ACHIEVABILITY OF GREEN BUILDING INDEX MALAYSIA

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A project report submitted in partial fulfilment of the requirements for the award of the degree of Bachelor (Hons.) of Quantity Surveying

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DECLARATION

I hereby declare that this project report is based on my original work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at UTAR or other institutions.

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APPROVAL FOR SUBMISSION

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Specially dedicated to

my beloved family and friends

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ABSTRACT

The introduction of sustainable development through the construction industry has been aroused, and the Green Building Index has been introduced in Malaysia. However, the implementation of Green Building Index in construction projects is not widely adopted. This research aims to investigate the perception of building professionals towards the criteria contained in Green Building Index (GBI) guidelines which must be fulfilled in the application for GBI certification. A critical review of the sustainable development and GBI category namely Energy Efficiency, Indoor Environmental Quality, Sustainable Site Planning and Management, Materials and Resources , Water Efficiency and Innovation was carried out. Questionnaire survey was conducted to seek for the perception of building professionals in the achievability of 63 GBI criteria. The results obtained from 62 samples indicated that the building professionals expressed a rather positive view towards the achievability of GBI criteria. Meanwhile, Indoor Environmental Quality is the easiest category to achieve while Materials and Resources is the hardest to achieve. Further breakdown of the category showed that Environmental Tobacco Smoke (ETS) Control is the easiest to be achieved and Redevelopment of Existing Site and Brownfield Sites is the hardest to achieve. Using Mann-Whitney U-Test, the subtle differences among the building professionals towards the achievability of GBI criteria were identified. The perception towards GBI certification is affected by the working nature of the profession. The barriers towards the achievability included “lack of training/education”, “perception of higher upfront cost”, “lack of technical understanding”, and “insufficient supply of product”. The results can used to serve as a basis to score in GBI certification and overcome the barriers.

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LIST OF SYMBOLS / ABBREVIATIONS

μ	Mean
σ	Standard Deviation
U	Mann-Whitney
ρ	Asymp. Sig. (2-tailed)
r	Effect Size
EE	Energy Efficiency
IEQ	Indoor Environmental Quality
SM	Sustainable Site Planning and Management
MR	Materials and Resources
WE	Water Efficiency
IN	Innovation
GBI	Green Building Index
GBIF	Green Building Index Facilitator
NGBIF	Non Green Building Index Facilitator
ETS	Environmental Tobacco Smoke
ACE	Air Change Effectiveness
ESC	Erosion & Sedimentation Plan
MSMA	Storm Water Management Manual for Malaysia

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CHAPTER 1

INTRODUCTION

1.1 Background

Sustainable development has been the key issue within these years and under the issue of “Greenery in Construction”, the green building has now become a flagship to takes the responsibility for balancing long-term economic, environmental and social health (H.Ali & Saba F, 2008).

There were several attempts at arising interests in this matter by the Malaysia government such as in setting up the green policies of National Energy Policy 1979, the green agencies of the Ministry of Energy, Technology and Water, GreenTech Malaysia, Green Technology Council, and Malaysia Green Building Confederation. It has addressed the importance of “Green” globally and its significance to be applied on construction projects (Chua & Oh, 2011).

However, there are always barriers in promoting the green building. Defining green can sometimes be a difficult task, because “green” can mean different things to different people. It has been addressed that the lack of expressed interest from the clients and hence the implementation cannot be carried out without the support of the client. The payback of the green building requires a very long period than a conventional building design (Gregory, 2005). Besides, it has been deemed that the alternatives for the green building design have been too costly as compared to the conventional building construction (Telegen, 2005).

On top of that, there are also voices that claiming that there are very limited sources for them in seeking for the green building's product which hampers them from adopting the method. The work flow on site have also been a matter of concern that the insufficient technical skill of the workers or staffs might cause the delay and difficulties in carrying out the works due to the advance technology of green building concept (Landman, 1999)

1.2 Problem Statement

The introduction of sustainable development through the construction industry has been aroused, and the Green Building Index has been introduced in Malaysia. However, the implementation of Green Building Index towards the construction projects is not widely adopted. By the year of 2011, there were only forty one construction projects that obtained the green building certification. So why the Green Building Index does has not being widely adopted in Malaysia? What are the perceptions of the building professions towards the achievability of GBI certification? Which are the criteria that deemed to be difficult and easy to achieve by various parties? This study will address the perception of the building profession towards GBI certification in Malaysia, and suggest a range of criteria that can be achieved by least barriers.

1.3 Aims

To investigate the perception of building professionals towards the criteria in Green Building Index (GBI) guidelines which to be fulfilled in the application of GBI certification.

1.4 Objective

In order to achieve the aim of this research, several objectives have been set out as the basis of this research:-

1. To investigate the perception of the building professionals towards the achievability of the criteria in GBI guidelines to obtain in the GBI certifications

2. To identify the reasons that halt the building professionals from adopting the Green Building Index certification in their construction projects.

3. To find out the relationship between the criteria in Green Building Index guidelines and the perception of building professionals towards the implementation of Green Building Index in Malaysia.

4. To develop a set of guidelines that can be adopted with least barriers in the implementation of GBI certification.

1.5 Research Method

Both the quantitative and qualitative research has been adopted. A comprehensive set of questionnaires will be distributed to the building professionals in Malaysia. A simple random sampling approach is adopted to obtain views from different range of building professionals.

1.6 Limitations and Scope of Work

This research was conducted based on the construction industry within Malaysia only. This research was designed for the personnel in construction industry, there could be respondents who had not possess the knowledge of green building and answered based on merely their perception in mind.

1.7 Report Structure

Chapter One: Introduction

In this chapter, it will give a general idea about the overview of the research title. Also it will draw the aim and objectives for this research in order to deliver the audience the significance of this research to be carried out. It will also outline the research methodology adopted and also the structure of the report.

Chapter Two: Literature Review

A comprehensive study on the sustainable development and the Green Building Index will be conducted. It will explain the aspects of the sustainable development in construction, the role of Green Building Index towards the sustainable development in Malaysia, the components of Green Building Index, and also the common barriers that is found to be obstructing the practice of sustainable development.

Chapter Three: Research Methodology

This chapter will outline the approach for the data collection. It will include the type of data to be collected, and also the nature of the data collection. It will also explain in detail the design of the questionnaire to achieve the aim of this research. This chapter will eventually introduce the method to be used in analysing the data obtained from research method.

Chapter Four: Results and Analysis

The result obtained through the questionnaire will then be analysed in this chapter. There will be various methods to be used to analyse the result obtained. Discussion will be carried out in this chapter with the perception of building professions towards GBI.

Chapter Five: Conclusion

Lastly, this chapter will draw a conclusion for the report regarding the research that will be conducted. It will also outline the limitation and shortcoming in this research and provide the guidelines and recommendations for the further study to encourage the practice of sustainable development in Malaysia.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The awareness among the nation with the issue of sustaining the environment has been risen up lately. In this literature, it covered the scope of introduction of sustainable development with its definition and its importance of this approach. It will also include the introduction of Green Building Index, generally giving an idea of the how the certification works. The following chapter will look into the detail of the assessment for Green building Index, i.e, Energy Efficiency, Indoor Environmental Quality, Sustainable Site Planning & Management, Water Efficiency, and Innovation.

2.2 Sustainable Development in Construction

2.2.1 Definition

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland, 1987). Also, a sustainable development should reduce current levels of consumption of energy and resources and production of waste in order not to damage the natural systems which future generations will rely on to provide them with resources, absorb their waste and provide safe and healthy living conditions (LGMB-Local Government Management Board, 1993)

2.2.2 Importance of Sustainable Development

Sustainable development includes passing on to future generations a stock of 'capital' that is at least as big as the one that our own generation inherited. Capital in this sense means the world's assets, these include money, buildings and less tangible assets such as the stoke of skills and social systems, as well as natural resources (American, 2008). It is very important on the conservation to ensure the future generations able to enjoy the same benefits as the current generation able to (Mawhinney, 2002).

Pursuing sustainable development through the usage in green technology in economic and social developments not only helps sustain the non-renewable fuels, safeguards and minimises the environmental degradation due to carbon emissions, it also creates a strong green economy and industry, in line with the country’s vision as well as the rest of the world economies. Through the green technology adopted, it will assist on the savings estimated of RM 1bil in energy related costs for users and RM 5bil related to investments in utility infrastructure. Through the approach of sustainable development, it will save the depleting non-renewable fuels as a sustainable development emphasized on the use of energy efficient approach which saves overall fuel consumption and extends the lifetime of scarce reserves. Most importantly, a sustainable development is needed to preserve the environment through using the green technology to minimize the exploitation of the natural environment (Chua & Oh, 2011).

2.3 Introduction of Green Building Index towards Sustainable Development

Over the years, the environmental issues have been arisen throughout the nation due to the global warming has jeopardized the earth. To save the earth, the construction industry has aroused the awareness of sustainable environment from green building. A green building refers to a structure and using process that is environmentally responsible and resource-efficient throughout a building's life-cycle: from sitting to design, construction, operation, maintenance, renovation, and demolition. (Green Building, 2007). It can be identified that most of the green elements are incorporated during the planning and design stage (Zhang, Platten, & Shen, 2011).

In Malaysia, the government has set up a system which is known as the "Green Building Index". The objective of this index is to create the awareness among the parties involved in the construction industry in the importance of sustainable construction. This system has set up a series of requirements which are deemed to be environmental friendly throughout the life cycle of the building construction (Green Building, 2007).

There are various green elements can be found in construction project including the site selection planning and design, construction and operation and maintenance of building (Zhang, Platten, & Shen, 2011). There are six (6) elements in the green building rating systems that will be looked into, which are Energy Efficiency (EE), Indoor Environmental Quality (IEQ), Materials and Resources (MR), Sustainable Site Planning & Management (SM), Water Efficiency (WE), and Innovation (IN) (Greenbuildingindex Sdn Bhd, 2008). Four (4) classifications are given for the green building certifications to show the gradient of compliance with the requirements namely Platinum, Gold, Silver and Certified certification (Greenbuildingindex Sdn Bhd, 2008).

2.4 Components of Green Building Index (GBI)

2.4.1 Energy Efficiency (EE)

In Malaysia, the government has been playing a role in promoting the importance of EE by implemented various EE initiatives covering incentives, education and subsidiaries over the last three decades (Manan, et al., 2010). It is noticed that the building professionals do not consider energy efficiency an issue that should be highlighted. (Lo, Zhao, & Cheng, 2006) .

In the lighting zone, it is encouraged with the usage of auto-sensor controlled lighting and motion sensor for lighting zoning. Individual switches shall be used for greater flexibility of light switching. Separate sub-metering for energy use ≥100 kVA shall be implemented and by using the Energy Management System to monitor and analyse energy consumption in the building. Sustainable maintenance to ensure the energy system will perform as expected beyond 12 months of Defects and Liability period has to be achieved by setting up the Energy Monitoring Committee (EMC) and providing a maitenance office and permanent maintenance team one (1) to three (3) months before practical completion (Greenbuildingindex Sdn Bhd, 2008).

2.4.1.1 Minimum EE Performance

The minimum energy efficiency (EE) performance is required to reduce energy consumption in the buildings and lead to reduction in carbon dioxide (CO_2). Calculation for Overall Thermal Transfer Value (OTTV) and Roof Thermal Transfer Value (RTTV) is required. An OTTV is a measure of energy consumption of a building envelope. Its formulation allows authorized persons, registered structural engineers and other persons responsible for the design and construction of buildings freedom to innovate and vary important envelop components such as type of glazing, window size, external shading to windows, wall colour and wall type (Liu, Meyer, & Hogan, 2010).

2.4.1.2 Renewable Energy

Renewable energy offers environmental attractive alternatives to the fossil fuel and nuclear power. Although Malaysia has high potential in solar electricity generation, the current initiatives is still lower that it can perform (Ahmad, Kadir, & Shafie, 2010) The electricity from the Photo Voltaics (PVs) and other renewable is somewhat more expensive than the electricity generated by the electricity generated by the conventional electric plant, however the energy efficient use of electric appliances have made the occupants' electricity needs to be more easily achieved. Also, the past decades have dramatic improvements on the renewable technologies which gradually reduce the cost at the same thing enhance its performance (Barnett & D.Browning, 2007).

However, there are issues to be highlighted in the hurdles of the adoption for renewable technologies, such as the absence of consistent development strategies, low level of education on its investigation, development and exploitation (Lalic, Popovskib, Gecevskac, Vasilevskad, & Tesica, 2011).

2.4.2 Indoor Environmental Quality (EQ)

An energy efficient strategy can be incorporated into passive design strategy which is mainly involved in the design stage and active design strategy which is mainly involved in the installation of mechanical elements. The equipment and appliance for natural ventilation and air conditioner has incurred a relatively high cost in implementing the green building projects (Zhang, Platten, & Shen, 2011).

The building is required to meet the minimum requirements of ventilation rate in Indoor Air Quality (IAQ) procedure of ASHRAE 62.1 or local building code. The purpose of the standard of ASHRAE 62.1 is to specify minimum ventilation rates and indoor air quality that will be acceptable to human occupants and are intended to minimize the potential for adverse health effects (Baxter, 2004). An attempt such as natural ventilation, exhaust duct location, and ventilation system control are the methods introduced in ASHRAE 62.1 (Dennis & Crosse, 2008).

Environmental tobacco smoke (ETS) control is emphasized to reduce health risk of the occupants. CO_2 sensor should be installed to adjust the outside air ventilation rates and the effort in preventing mould growth. Low volatile organic compounds (VOC) should be used as VOC is any organic compound which, once released into the atmosphere, can remain there for a long period to participate in photochemical reactions, and some of the compound is relatively hazardous for human's health (Voirol, 2000). Thermal comfort, Air Change Effectiveness (ACE), breakout space, daylighting, daylight glare control, electric lighing levels to maintain a specified luminance level, high frequency ballasts, direct view to the outside, control of internal noise levels, post occupancy survey and IAQ Management Plan must be conducted with compliance of the GBI requirements.

2.4.2.1 Environmental Tobacco Smoke (ETS) Control

Most of the time, cigarette smoking can be found at anywhere, including the indoor environment. ETS has been has been defined as the smoke which non smokers are exposed to when they are in an indoor environment with smokers (McNabola, B.M., Johnston, & Gill, 2006). Because of the known harmful effects of many of the compounds found in ETS, there is much concern over exposure to ETS (Ning, Cheung, Fu, Liu, & b, 2006). In response to this environmental health issue, several countries have brought about a smoking ban policy in public places and in the workplace (McNabola & Gill, 2009).

To control the ETS, prohibition of smoking in the air conditioned public building through supervision and signage, locate exterior designated smoking areas and air filtration system can be implemented. Extra cost may incur in the event of the designated smoking space for the smokers (Canadian Centre for Occupational Health & Safety, 2011).

2.4.2.2 Air Change Effectiveness (ACE)

Air change effectiveness is a measurement of the performance of the effectiveness in air distribution system in supplying outdoor to a room, by measuring the age of air in a volume (Alan Mascord Design Associates, Inc., 2009). The age of air is the length of time the outdoor air supplied by a system remain in a ventilated space (Awbi, 2003). It can be measured in accordance with ASHRAE 129 or equivalent, the CFD simulations or approved airside design strategy. Low ACE can occur with heating systems. People have mistakenly assumed that under floor supply systems and displacement ventilation systems have inherently high ACE, but that is only true when cooling. These systems have low ACE when heating, often lower than conventional overhead systems (Steven T. Taylor, 2005).

2.4.2.3 High Frequency Ballast

A high frequency ballast is An electronic ballast that operates the lamps above 20kHz. The main advantage of high-frequency ballast is the improvement of efficacy, and reduce lamp flickering that is sometimes associated with low-frequency ballast, as the lamp phosphors are refreshed more often (Hearst Business Communications, 2005). However, there are criteria should be concerned during the selection of high frequencies ballast. The starting method of the ballast such as the rapid start will heat the electrodes before the obtain sufficient voltage to start the lamp and this will contribute to slight delay in turning on the lamp, results in power loss of 3-4 watts. On the other hand, the instant start does not require excessive heating to the electrodes. Due to the high initial votes applied on the ballast, it will relatively reduce the lamp life, especially when the lamps are switched on and off frequently, which occur during the application of motion sensory occupancy (National Lighting Information Program, 1996).

2.4.3 Sustainable Site Planning & Management (SM)

A site planner should consider how to minimize the disturbed area for the project. The key element of minimizing the disturbed area is the degree to which habitat and open space are preserved and created (Russ, 2009). The selection of site plays a crucial role in this section. The building should be constructed with a minimum density of 20,300 m^2 per hectare net. Also, it would be the best if it is located within 1km of residential zone or at least ten (10) basic services. Redevelopment of existing site can reduce the exploitation of site where the natural environment is preserved.

During the earthworks, the activities should be conducted in a way to prevent loss of soil, sedimentation of storm water and air pollution with the aid of implementing an ESC Plan. Storm water design must be taken care to reduce the disruption of natural water courses by provide on-site infiltration of contaminants, reduce impermeable surface and encourage groundwater recharge (Schiler, 2005). The use of greenery on rooftops can help reduce urban heat island effects cooling and and shading the buildings. The policy can be established to encourage the use of carpools and green vehicle, i.e low emitting and fuel efficient vehicles by providing them the priority of carpark.

2.4.3.1 Integrated Pest Management, Erosion Control & Landscape Management

Under this section, its main purpose is to be sensible towards the protection of the environment in the process of pest management, erosion control and landscape management. The Plan should designed to minimize the impact of site management practices on the local ecosystem and the environment, reduces the exposure of occupants, staff, and maintenance personnel to potentially hazardous chemical, biological, and particle contaminants during the process. Various party will have to be hired in order to work out this plan, such as the landscape maintenance company and pest control company (Yackzan Group, 2001).

2.4.3.2 Re-development of Existing Sites & Brownfield Sites

Brownfield are generally defined as premises or lands that has been previously used, or developed, is not currently fully in use, although it may be partially utilized or occupied (Brebbia & Mander, 2006). Not all contaminated site can be named as brownfield, only when there is redevelopment potential of the site. In Malaysia, there are more than 800,000 hetares of derelict land.

Site assessment, cleanup cost, and the post cleanup cost is the additional costs incur which becomes a major prohibitive reason for the project proponent (Chun-Yang & Abdul, 2006). Developing a brownfield might expose the designer to the inherent challenges on the site conditions and restrictions such as the certain degree of contamination. Normal practice of landscaping design and stormwater design may be restricted on such conditions and require a special designs and plant materials (Russ, Redeveloping Brownfields: Landscape Architects, Planners, Developers, 2000). There is said to be a number of issue might be occur during the development of brownfield, such as it lack of access to capital and insurance protection, risk percrption due to regulatory and civil liability, and lack of awareness of the public (Ministry of Environment, 2007).

Selection of appropriate project site is never easy as every project's characteristic is heterogeneous and to fulfill every single aspect required for the project. With the rarity of existing site, it makes it harder for a developer to find an appropriate brownfield site for development.

2.4.3.3 Stormwater Design – Quality & Quantity Control

A stormwater design in a construction project can relatively get rid of the negative consequences as a result of excessive stormwater trapped on the ground (Rushton & Bongiorno, 2006). Road density, pavement coverage percentage of gross land area, is more likely will bring an impact to the stormwater runoff consequences such as flood.

MSMA shall be complied and it comprises of flow control requirements, drainage system, signage, landscaping imperviousness, roof system, storage tank for stormwater, piping system and etc (River Engineering and Urban Drainage Research Centre, 2007). Even though guidelines can be used for the design, there are always the inherent challenges for the designers to consider. The identification of the stormwater flow rate for future occupation is not an easy task, due to the difficulty to forecast permeability soil rates (Goldenfum, Tassi, Meller, & G., 2007).

2.4.3.4 Quality Assessment System in Construction (QLASSIC)

Quality Assessment System in Construction (QLASSIC) is a system or method to measure and evaluate the quality of workmanship of a construction work based on the relevant approved standard. QLASSIC enables the quality of workmanship between construction projects to be objectively compared through a scoring system. The purpose of this scheme is to enable a construction project to be undergone in standard of procedure in order to ensure the quality of workmanship in the works (CIDB MAlaysia Offical Portal, 2011). Extra cost may incur due to the compliance to this system on the documentation and workmanship required during the application and special procedure required during implementation.

2.4.4 Materials and Resources (MR)

The materials used are very important in reducing the environmental impact caused during the extraction and processing of virgin resources by reuse the products and pre consumer content or post consumer recycled content materials (Wilson & Piepkom, Green building products: the GreenSpec® guide to residential building materials, 2008). Construction waste management plays a role in diverting the construction waste or debris from disposal from landfill. Redirect the reusable materials to the relevant site and the recyclable materials to the manufacturing factories respectively. A proper storage area and recycle bin shall be prepared to store the non hazardous materials for recycling to reduce waste. As timbers are produced from the limited plants, the proof of certified wood-based materials must be obtained in order to identify the materials used are not illegal and also encourage the environmentally responsible forest management (Meisel, 2010). Environmental friendly with Ozone Depleting Potential (ODP) products of cleaning agents and refrigerants can be used to reduce environmental impacts.

2.4.4.1 Regional Materials

The regional materials are defined as the materials or components manufacturing no more than 500 miles from the construction site (Accurate Perforating Company, Inc., 2011). In Malaysia's case, it limits to 500km. Fuel and air pollution from transport of materials over great distances is reduced, thus reducing greenhouse gas emissions and air pollution. The location of project site could be varies from central business district to rural area. The source of the regional materials may be the constraint to its application as supply of a material located locally does not necessarily mean it is locally sourced. Furthermore, the techniques and materials used in a green building project could be different which rendered it harder to be found. The common practice of the construction personnel has keen to obtain the overseas products that import in a bulk quantity and it could reduce the overall cost as compared to the adoption of regional materials (State University of New Jersey, 2011). Information is limited to an occasional description of the material's appearance without providing a clear and comprehensive overview that might be useful to architect designers (Wastiels & Wouters, 2012).

2.4.5 Water Efficiency (WE)

The supply of edible water is limited, if the level consumption of the water remains, the human will suffer from the water stress soon (Report, 2006). The GBI has introduced the rainwater harvesting system to reuse the rainwater and the greywater, i.e all waste produced in the home is greatly encouraged for recycling for building consumption or irrigation (Ridderstolpe, 2004). The type of plant for landscaping could also contribute for the water reduction such as the native and adaptive plant. Another way to reduce the water usage is to use adequate water system such as automatic self-closing equipments to get rid of further water wastage.

Water submetering and leak detection systems already required to achieve WE that allows monitoring and management of water consuptiom. The common water meter has low sensitivity towards the small water consumption such as water leakage (Fletcher & Deletic, 2007).

2.4.5.1 Water Recycling

Water recycling is incorporated in the green strategy to achieve water efficiency. The recycling is by means of recover the water that would otherwise be directed to the waste system and cleaning it for reuse in portable water consumption (Ahuja, 1997). There are several water recycling systems that can be used, such as the membrane bioereactor process (MBR) in residential premises, Ultra Biological System (UBIS) for large building and Collective Night-Soil Treatment Plants for the sludge generated during the on-site treatment. MBR is used in small waste water system plants due to its high investment on initial cost of installation of the membrane (AWWA Research Foundation, 1996).

2.4.6 Innovation (IN)

To encourage the design integrated with the requirement of GBI and streamline the application and certification process, it is encouraged to have at least one key participant in the project to be the GBI Facilitor. In addition, any initiation in adopting a better innovation system other than the requirements in constructing the building will be added additional points (Greenbuildingindex Sdn Bhd, 2008).

2.4.6.1 Green Building Index (GBI) Facilitator

Appointment of GBI facilitator to engage throughout the construction duration from design phase till project completion is to streamline the application and certification process. Up to March 2012, there has been 493 qualified GBIF are available in Malaysia (Greenbuildingindex Sdn Bhd, 2008). The professional fees of GBIF is not fixed and it will solely depends on the preference of the GBIF.

Table 2.1 : Recommended GBI Facilitators Scale of Fees

Item	Start	End	Cost Range (RM)	Minimum Fee (RM)	% Add On	Maximum Fee (RM)	Max Overall Fee %
1	0	10,000,000	10,000,000	10,000	0.40	40,000	0.40
2	10,000,001	50,000,000	39,999,999	40,000	0.35	180,000	0.36
3	50,000,001	150,000,000	99,999,999	180,000	0.25	430,000	0.29
4	150,000,001	300,000,000	149,999,999	430,000	0.10	580,000	0.19
5	300,000,001	500,000,000	199,999,999	580,000	0.08	730,000	0.15
6	500,000,001	above	730,000	Negotiable			

2.5 Barriers to Implement the Green Building Concept

2.5.1 Lack of Awareness

Even though the awareness of sustainable development has been aroused, yet the education for the practice is still insufficient. Most of the stakeholders often overlook the importance of the green concept to be applied into construction and hence it is common that these concepts will be resisted naturally. Without proper education, the demand for sustainable development will not be obtained (Landman, 1999).

2.5.2 Perception of Higher Cost for Sustainable Options

It is common that there is always the perception that cost required for green building alternatives are always higher than the conventional building method. This is due to the cost of a building is often measured in terms of the construction cost instead of the life cycle cost. It has been stated that the cost efficient will ultimately benefits the owner, but not the developer. Generally, the developer will always emphasize of the instant payback rather than the return in a long run. The additional cost can be incurred from many aspects, it can be the higher purchase cost, the learning curve cost, employing skilled labour and the special design work programme for the project (Zhang, Platten, & Shen, 2011).

2.5.3 Insufficient Supply of Green Product

There is saying about the supply of green building product is not as easy to reach compared to the conventional building materials because it has not been widely promoted in the country. In most of the country whereby the developments of green buildings are still in initial stage, most of the green technologies and green product have yet to form a mature system for the user (Landman, 1999).

2.5.4 Lack of Technical Understanding

Due to the green technologies that being introduced are always something innovative, it will cause the lack of understanding of the staff in the constructions regarding the technical specifications and operation of the technologies. Undoubtedly, it would contribute a higher risk that error and delay will occur throughout the construction process due to unfamiliarity of the skill possessed (Zhang, Platten, & Shen, 2011).

2.5.5 Confidence on Sustainable Options

The reliability of the green buildings product is yet to be observed. For the green approaches such as the utilization of renewable energy, it is said to be fluctuating performance because it has to rely on the seasonal fluctuations and weather, which is beyond human's control (Zamzam Jaafar, Kheng, & Kamaruddin, 2003).

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter introduced the research method adopted to carry out the research and the source of the data obtained. The survey instrument and its structure were discussed, which the questionnaire survey was used to obtain the result for analysis. The type of sampling used for this analysis was introduced and the method of analysis used in this research.

3.2 Research Method

This research studied the behaviour and the relationship of the samples through likert scale on the GBI criteria towards its achievability. Quantitative research was used in this research to measure the variables that are considered (Wimmer & Dominick, 2010). It was an inquiry into a social or human behaviour and measured with numbers and analysed with statistical procedure. (Naoum, 2007). Open ended questions were used in this research to find out the reason behind which the samples deem that the criteria were hard to achieve. Meanwhile, the attitudinal research was used to evaluate the view towards a particular scale.

3.3 Data Collection

There were two approaches to collect the data in order to conduct this research, which was the fieldwork research (primary data collection) and desk study (secondary data collection) (Kothari, 2008). The primary data was obtained through the questionnaire survey which discussed in later part. Meanwhile, the secondary data of this research was obtained in the literature review and used in the result analysis of this research. The source for the literature review comprised the journals obtained from Science Direct and other electronic source, books, articles and etc.

3.4 Survey Instrument

A survey questionnaire was used to conduct the survey in this research because it would be the best way to obtain massive information to achieve the objective of this research. Also, the questionnaire survey can be administered in faster pace as it sent out and returned in bulk.

Generally the questionnaire survey was formulated in two forms, which were the open ended and the closed ended questions. The questionnaires consisted of two sections. The first section focused on the 63 criteria obtained from the GBI guideline tools to obtain the professions' view in terms of its achievability. It was a closed questions and the respondents were asked to be rating the 5-point likert scale accordingly from 1 (Most Difficult), 2 (Difficult), 3 (Neutral), 4 (Easy) and 5 (Easiest). The closed ended questions provided a number of responses for the respondent and the questions were easy and quick to answer, the data was converged and the analysis was being straightforward. However, the major setback of this method was that the rigidity of the questions constraint the respondent from having an alternatives of their true view. Also, the feedback of the questionnaire had performed in a lower rate return.

On the criteria whereby the respondent deemed that it was the most difficult to achieve, the respondents were asked to provide an open answer to state their justification. The open ended questions were to ask questions which seek to encourage the respondent to provide free responses to reach a higher degree of accuracy in the questionnaire to achieve the aim of this research. However, problems usually occur in this method that the responses of the questions were be too broad and make the interpretation of the responses to be difficult (Fellows & Liu, 2008).

The second section involved the factual questions that designed to understand the background of the individual. It comprised of the questions of the professions of the respondents holding, primary types of building involved, experiences in construction field, involvement in green building project and whether he is a GBI facilitator. Also, the particular of the respondent such as name, company name, mailing address, and contact number were required for the ease of future reference.

3.5 Survey Sample

A simple random sampling approach was used for the distribution of questionnaire surveys. In this research, the sample selected was open to Malaysia to obtain as much as the information. The samples were divided into few categories based on their designation / title, such as the civil engineer, mechanical engineer, architect, quantity surveyor etc. It is the sample that being chosen randomly from a whole population and it is selected independently (Anderson, Sweeney, Williams, & Williams, 2008).

3.6 Method of Analysis

In order to analyse the data that obtained, the software of Statistical Package of Social Science (SPSS) will be used. Descriptive Statistic and the tests such as the Descriptive Statictic, One-Way ANOVA tests, and the non parametric test,i.e Kruskal Wallis test and Mann-Whitney U-test were conducted.

3.6.1 Descriptive Statistic

There are 63 criteria had been taken into this analysis to identify their descriptive data, i.e. its mean from ascending to descending manner. The purpose was to find out the criteria from the hardest to achieve to the easiest to achieve which was perceived by the professions.

3.6.2 One-Way ANOVA

This test was used to analyse the variances when all explanatory variables are categorical (Crawley, 2005). The 63 criteria are further scope down to 6 categories respectively. Then the test was again being run for the same purpose but in terms of category wise. The 6 categories was used as the dependent variables mean while the groups of respondents who holds different profession, whether involved in a green building project, and whether they are a GBI facilitator were used as a factors respectively. The purpose is to study their perception of achievability towards the 6 categories in the GBI certification.

3.6.3 Kruskal-Wallis (K Statistic)

This test was used for samples for more than two populations and was one way analysis of variance by ranks (Sharma, 2005). The objective of this test was to identify whether the independent samples were from identical populations (Panneerselvam, 2004). This test had been used against the 63 criteria and compared with the groups of respondents who held different profession were used as a factor. The purpose was to study whether there was any significance difference in their perception of achievability towards the 63 criteria in the GBI certification within groups. The criteria that were found to be consist of significance differences between the groups were brought to the next level of test, i.e The Mann-Whitney U-Test.

3.6.4 Mann-Whitney U-Test

It was a non parametric counterpart of the t test used to compare the means of two independent variable (Black, 2009). This test had been used against the 63 criteria and compared with the pairs of respondents who helf different profession, whether involved in a green building project, and whether they are a GBI facilitator were used as a factors respectively. The purpose was to study whether there is any significance difference in their perception of achievability towards the 63 criteria in the GBI certification within groups.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter outlined the results that obtained from the analysis and the discussion of the research finding.

4.2 Analysis of Results

4.2.1 Respondents Profile

There were total of 1000 sets of questionnaire sent out to the building professionals via email and by hand. Out of the 1000 sets, there were 65 questionnaires that were replied and 3 sets were invalid due to the incomplete responds in the questionnaire. The distributions of respondents' profiles are as followed.

Table 4.1 : Data Distribution and Collection

Distributed Questionnaire	1000 sets
Collected Data	65 sets
Usable Data	62 sets (6.2%)

Table 4.2: Distribution of Sampling

Descriptions	Frequencies	Percentage (%)
A. Profession		
Architect	5	8%
Contractor	9	15%
Sub Contractor	1	2%
Quantity Surveyor	23	37%
M&E Engineer	14	23%
Civil Engineer	6	10%
Others	4	6%
B. GBI Facilitator		
Yes	24	39%
No	38	61%
C. Involved in Green Building Project		
Yes	33	53%
No	29	47%

Most of the professions that completed the questionnaire are the Quantity Surveyors (37%). Other professions, the Architect (8%), Contractor (15%), Sub Contractor (2%), M&E Engineer (23%), Civil Engineer (10%) and others (6%) had shown the the rest of sampling distribution in this research. Meanwhile, the frequencies of GBIF (39%) and individual that involved in a green building project (53%) had almost hit a balance among the population group.

4.2.2 Comparison of the Average of Dependant and Independent Variables

4.2.2.1 GBI Criteria and Category

Table 4.3: Mean and Standard Deviation of GBI Category

Category	Mean (μ)	Std. Deviation (σ)
Energy Efficiency (EE)	3.17	0.48
Indoor Environmental Quality (IEQ)	3.38	0.39
Sustainable Site Planning and Management (SM)	3.19	0.47
Materials and Resources (MR)	3.08	0.71
Water Efficiency (WE)	3.33	0.73
Innovation (IN)	3.37	0.87

Table 4.4: Mean and Standard Deviation of GBI Criteria

Item	Criteria	Mean (μ)	Std. Deviation (σ)
1)	Environmental Tobacco Smoke (ETS) Control	3.97	1.04
2)	Electric Lighting Levels	3.82	0.84
3)	Sound Insulation	3.79	0.83
4)	Lighting Zoning	3.68	0.88
5)	Green Building Index Facilitator	3.63	1.16
6)	Water Efficient Fittings	3.61	0.89
7)	Daylight Glare Control	3.6	0.9
8)	Parking Capacity	3.6	1.05
9)	Building User Manual	3.6	1.09
10)	Daylighting	3.55	0.9
11)	High Frequency Ballasts	3.53	0.86
12)	Home Office & Connectivity	3.52	0.99
13)	Thermal Comfort: Design & Controllability of Systems	3.52	0.8
14)	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	3.52	1.2
15)	Minimum Indoor Air Quality Performance	3.48	0.84
16)	Storage, Collection & Disposal of Recyclables	3.45	1.02
17)	Electrical Sub-metering	3.44	0.9
18)	Internal Noise Levels	3.44	0.86
19)	External Views	3.4	0.9
20)	Rainwater Harvesting	3.39	0.98
21)	Metering & Leak Detection System	3.34	1.04
22)	Greenery & Roof	3.34	1.02
23)	Water Efficient Irrigation/Landscaping	3.34	0.89
24)	Integrated Pest Management, Erosion Control & Landscape Management	3.34	0.89
25)	Building Exterior Management	3.34	0.75
26)	Workers' Site Amenities	3.31	0.86
27)	Open Spaces, Landscaping & Heat Island Effect	3.29	1.06

Item		Mean (μ)	Std. Deviation (σ)
28)	Energy Efficiency Verification	3.29	0.96
29)	Refrigerants & Clean Agents	3.27	0.96
30)	Environment Management	3.27	0.73
31)	Regional Materials	3.27	0.99
32)	Carbon Dioxide Monitoring and Control	3.24	0.97
33)	Sustainable Maintenance	3.21	1.03
34)	Construction Waste Management	3.19	1.02
35)	Mould Prevention	3.19	0.83
36)	GBI Rated Design & Construction	3.19	0.9
37)	Post Occupancy Comfort Survey: Verification	3.19	0.88
38)	Stormwater Design - Quality & Quantity Control	3.16	0.91
39)	Public Transportation Access & Transportation Plan	3.16	0.89
40)	Minimum Energy Efficient (EE) Performance	3.15	0.92
41)	Good Quality Construction	3.15	1.02
42)	On-going Post Occupancy Commissioning	3.15	0.9
43)	Advanced EE Performance based on Roof Thermal Transfer Value (RTTV)	3.13	0.86
44)	Innovation & Environmental Design Initiatives	3.11	0.99
45)	Breakout Spaces	3.11	0.81
46)	Noise Pollution	3.11	0.75
47)	Indoor Air Pollutant & Industrial Chemical Exposure	3.11	0.93
48)	Air Change Effectiveness	3.06	0.99
49)	Enhanced Commissioning	3.06	0.88
50)	Quality Assessment System in Construction (QLASSIC)	3.05	0.95
51)	IAQ Before & During Occupancy	3.03	0.85
52)	Sustainable Purchasing Policy	2.98	0.9
53)	Cargo Delivery Route and Proximity	2.98	0.76
54)	Water Recycling	2.97	1.14
55)	Development Density & Community Connectivity	2.92	0.84
56)	Avoiding Environmentally Sensitive Areas	2.89	0.96
57)	Sustainable Timber	2.85	1.05
58)	Advanced EE Performance based on Overall Thermal Transfer Value(OTTV)	2.85	0.85
59)	Renewable Energy	2.81	1.29
60)	Recycled Content Materials	2.79	1.03
61)	Materials Reuse and Selection	2.79	1.09
62)	Advanced or Improved EE Performance - Building Energy Intensity (BEI)	2.76	0.92
63)	Re-development of Existing Sites & Brownfield Sites	2.42	0.98

From table 4.4, the criterion of Environmental Tobacco Smoke (ETS) Control (μ: 3.97, σ: 1.04) was perceived to be the easiest criteria to achieve during the implementation of GBI certification by the professions. At the mean time, Re-development of Existing Sites & Brownfield Sites (μ: 2.42, σ: 0.98) was deemed to be the hardest criteria to achieve.

Other than ETS Control, Electric Lighting Levels (μ: 3.82, σ: 0.84), Sound Insulation (μ: 3.97, σ: 0.83), Lighting Zoning (μ: 3.68, σ: 0.88), Green Building Facilitator (μ: 3.63, σ: 1.16), Water Efficient Fittings (μ: 3.61, σ: 0.89), Daylight Glare Control (μ: 3.60, σ: 0.90), Parking Capacity (μ: 3.60, σ: 1.05), Building User Manual (μ: 3.60, σ: 1.09), and Daylighting (μ: 3.55, σ: 0.90) were the criteria that easily to achieve perceived by the respondents.

Advanced or Improved EE Performance- BEI (μ: 2.76, σ: 0.92), Materials Reuse and Selection (μ: 2.79, σ: 1.09), Recycled Content Materials (μ: 2.79, σ: 1.03), Renewable Energy (μ: 2.81, σ: 1.29), Advanced EE Performance Based on OTTV (μ: 2.85, σ: 0.85), Sustainable Timber (μ: 2.85, σ: 1.05), Avoiding Environmentally Sensitive Areas (μ: 2.89, σ: 0.96), Development Density & Community Connectivity (μ: 2.92, σ: 0.84), Water Recycling (μ: 2.97, σ: 1.14), were the criteria that is difficult to achieve for the respondents other than Redevelopment of Existing Sites & Brownfield Sites as the hardest to achieve.

The means of the 63 criteria had been grouped into 6 main categories headings and their mean were computed. From table 4.3, it shown that there were only slight different with the mean of each category. The result showed that the IEQ (μ: 3.38, σ: 0.39) the easiest to achieve. MR (μ: 3.08, σ: 0.71) was likely to be the most challenging among the 6 main categories. In addition, the majority of the criteria in IEQ were found to be easier to achieve also. This further affirms the finding of IEQ is the easiest category to achieve. For the groups of criteria that were hard to achieve, namely EE, SM, and MR consist of 3 criteria in each of them respectively. These 3 group of categories were somehow the difficult according to table 4.3.

4.2.2.2 GBI Facilitators and Non GBI Facilitators

Table 4.5: Mean and Standard Deviation of GBI Category by GBI Facilitators and non GBI Facilitators

Category	GBI Facilitator		Non GBI Facilitator	
	Mean (μ)	Std. Deviation (σ)	Mean (μ)	Std. Deviation (σ)
Energy Efficiency (EE)	3.22	0.54	3.14	0.44
Indoor Environmental Quality (IEQ)	3.41	0.47	3.36	0.35
Sustainable Site Planning and Management (SM)	3.28	0.36	3.14	0.53
Materials and Resources (MR)	3.05	0.72	3.09	0.71
Water Efficiency (WE)	3.32	0.74	3.34	0.73
Innovation (IN)	3.85	0.68	3.07	0.85

There is a difference between the GBIF and NGBIF on the achievability of GBI criteria. For GBIF, the hardest category to score seems to be MR (μ: 3.05, σ: 0.72) while the easiest category is IN (μ: 3.85, σ: 0.68). However, the group of NGBIF had diverse view with the GBIF that IN (μ: 3.07, σ: 0.85) seems to be the hardest category. At the same time, IEQ (μ: 3.36, σ: 0.35) has deemed to be the easiest category to be achieved by NGBIF. Somehow, there was a correlation between the view of GBIF, NGBIF, and the overall's views. In general, the NGBIF's view of IEQ to be the easiest category to achieve had the dominant in the overall result. On the other hand, MR was the hardest category to score in the overall result and it was equivalent to the GBIF's view.

4.2.2.3 Involvement in Green Building Project

Table 4.6: Mean and Standard Deviation for of GBI Category by Groups of Involvement in Green Building Project

Category	Have Involved in Green Building Project		Have not Involved in Green Building Project	
	Mean (μ)	Std. Deviation (σ)	Mean (μ)	Std. Deviation (σ)
Energy Efficiency (EE)	3.21	0.47	3.12	0.50
Indoor Environmental Quality (IEQ)	3.37	0.41	3.39	0.38
Sustainable Site Planning and Management (SM)	3.16	0.42	3.22	0.53
Materials and Resources (MR)	3.11	0.79	3.04	0.62
Water Efficiency (WE)	3.34	0.80	3.32	0.66
Innovation (IN)	3.50	0.93	3.22	0.80

2 groups of sample who have been involved in green project and those who have yet to involve in a green project is then be observed. From table 4.6, it can be told that there was a slight different in the mean score of each group in each category. However, it can be seen that the views towards the achievability of the category by means of sample grouping of GBIF and NGBIF, and the groups who involved in a green project while another group did not, possessed similar views. For the groups who have involved in green project, the hardest category to score seems to be MR (μ: 3.11, σ: 0.79), which was the same as to the overall view. Meanwhile the easiest category to achieve was IN (μ: 3.50, σ: 0.93). However, for those who never been involved in a green project, they shared the same view that MR (μ: 3.04, σ: 0.62) seems to be the hardest category to be scored in attaining the GBI. At the same time, IEQ (μ: 3.39, σ: 0.38) had deemed to be the easiest category to be achieved by. Both of the results are equivalent to the overall views.

4.2.2.4 Profession

Table 4.7: Mean and Standard Deviation of GBI Category by Professions

Category	Mean (μ)						
	Architect	Contractor	Sub Contractor	Quantity Surveyor	M&E Engineer	Civil Engineer	Others
Energy Efficiency (EE)	2.88	3.31	3.08	3.13	3.26	3.06	3.31
	0.59	*0.43*	.	*0.52*	*0.34*	*0.57*	*0.65*
Indoor Environmental Quality (IEQ)	3.01	3.32	3.32	3.37	3.49	3.44	3.61
	0.52	*0.43*	.	*0.29*	*0.50*	*0.31*	*0.16*
Sustainable Site Planning and Management (SM)	3.07	3.03	2.68	3.09	3.42	3.23	3.53
	0.15	*0.49*	.	*0.46*	*0.53*	*0.36*	*0.50*
Materials and Resources (MR)	2.65	2.86	2.88	3.17	3.33	2.96	2.91
	0.73	*0.92*	.	*0.71*	*0.66*	*0.63*	*0.44*
Water Efficiency (WE)	3.32	3.16	3.20	3.40	3.63	2.93	2.90
	0.69	*0.67*	.	*0.84*	*0.60*	*0.59*	*0.77*
Innovation (IN)	3.20	2.78	2.50	3.15	4.14	3.33	3.75
	0.57	*0.79*	.	*0.85*	*0.60*	*0.93*	*0.65*

**Figure in italic indicates the standard deviation (σ) of the variables.*

From the table 4.7, Architects suggested that WE (μ: 3.32, σ: 0.69) was the easiest category to score while MR (μ: 2.65, σ: 0.73) was the hardest. The Contractors and Sub Contractors perhaps had consensus towards the easiest category to achieve to be IEQ (μ: 3.32,3.32, σ: 0.43,NIL) and the hardest to achieve to be IN (μ: 2.78,2.50, σ: 0.79,NIL). The groups of Quantity Surveyor had rather different views that WE was the easiest category to score (μ: 3.40, SD: 0.84) while SM was the most challenging category to score (μ: 3.09, σ: 0.46). The M&E engineers agreed that the IN (μ: 4.14, σ: 0.60) was the easiest to score while EE (μ: 3.26, SD: 0.34) was the most difficult to score. However, the groups of Civil Engineer suggested that IEQ (μ: 3.44, σ: 0.31) has the least barriers to implement while WE (μ: 2.93, σ: 0.59) was the hardest categories to achieve. As for the other profession, they deemed that IN (μ: 3.75, σ: 0.65) was the easiest to score while WE (μ: 2.90, σ: 0.77) was the hardest to achieve in order to obtain the GBI certification.

4.2.3 Comparison of the Behaviour of Dependant and Independent Variables

4.2.3.1 GBI Facilitators and Non GBI Facilitators

Table 4.8: Comparison of GBI Criteria between GBI Facilitators and Non GBI Facilitators

Criteria	Mean Rank		Mann-Whitney U (U)	*Z*	Asymp. Sig. (2-tailed) (ρ)	Effect Size (*r*)
	Yes	No				
Minimum Energy Efficient (EE) Performance (F1)	35.58	25.45	326.50	(1.97)	0.05	0.25
Renewable Energy (F2)	19.20	34.30	219.00	(3.51)	0.00	0.45
Environmental Tobacco Smoke (ETS) Control (F3)	39.30	23.43	225.50	(3.51)	0.00	0.45
Air Change Effectiveness (F4)	22.20	32.68	292.00	(2.48)	0.01	0.32
High Frequency Ballasts (F5)	37.80	24.24	231.50	(3.50)	0.00	0.44
Post Occupancy Comfort Survey: Verification (F6)	37.43	24.45	308.50	(2.29)	0.02	0.29
Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle (F7)	43.30	21.27	130.00	(4.86)	0.00	0.62
Parking Capacity (F8)	38.23	24.01	246.50	(3.14)	0.00	0.40
Building User Manual (F9)	38.15	24.05	241.00	(3.22)	0.00	0.41
Re-development of Existing Sites & Brownfield Sites (F10)	19.98	33.88	260.00	(2.99)	0.00	0.38
Stormwater Design - Quality & Quantity Control (F11)	35.83	25.31	313.50	(2.19)	0.03	0.28
Regional Materials (F12)	34.95	25.78	323.50	(2.01)	0.04	0.25
Water Recycling (F13)	22.45	32.54	286.50	(2.55)	0.01	0.32
Metering & Leak Detection System (F14)	36.38	25.01	295.50	(2.42)	0.02	0.31
Green Building Index Facilitator (F15)	41.23	22.39	168.50	(4.29)	0.00	0.55

**Only significant results of Mann-Whitney U-test are shown. Please refer to Appendix A for the complete results.*

From the table 4.8, there are 15 criteria were found to be consist of significance difference between the GBIF and the NGBIF in the views of their level of difficulties in achieving the criteria.

From the table, the GBIF's views were significantly different from the NGBIF on F2 (U=219.00, ρ=0.00, r=0.45), F3 (U=225.50, ρ=0.00, *r*=0.45), F7 (U=130.00, ρ=0.00, *r*=0.62) and F15 (U=168.50, ρ=0.00, *r*=0.55) which their relationship of effect size had indicated a much larger than typical strength of association. Other than F2, the NGBIF had scored a lower mean rank than the GBIF.

Whereby the GBIF's views were significantly different from the NGBIF on F5 (U=231.50, ρ=0.00, *r*=0.44), F8 (U=246.50, ρ=0.00, *r*=0.40), F9 (U=241.00, ρ=0.00, *r*=0.41) and F10 (U=260.00, ρ=0.00, *r*=0.38) which their relationship of effect size had indicated a large or larger than typical strength of association. Other than F10, the NGBIF had scored a lower mean rank than the GBIF.

The GBIF's views were significantly different from the NGBIF on F1 (U=326.50, ρ=0.05, *r*=0.25), F4 (U=292.00, ρ=0.01, *r*=0.32), F6 (U=308.50, ρ=0.02, *r*=0.29), F11 (U=313.50, ρ=0.03, *r*=0.28), F12 (U=323.50, ρ=0.04, *r*=0.25), F13 (U=286.50, ρ=0.01, *r*=0.32) and F14 (U=295.50, ρ=0.02, *r*=0.31) which their relationship of effect size had indicated medium to typical strength of association. Other than F4 and F13, the NGBIF had scored a lower mean rank than the GBIF.

4.2.3.2 Involvement in Green Building Project

Table 4.9: Comparison of GBI Criteria between the Groups of Involvement in Green Building Project

Criteria	Mean Rank		Mann-Whitney U (U)	*Z*	Asymp. Sig. (2-tailed) (ρ)	Effect Size (*r*)
	Yes	No				
Home Office & Connectivity (F1)	33.93	23.89	340.50	(2.05)	0.04	0.26
Environmental Tobacco Smoke (ETS) Control (F2)	32.83	25.04	307.50	(2.54)	0.01	0.32
Air Change Effectiveness (F3)	25.43	32.70	332.50	(2.16)	0.03	0.27
High Frequency Ballasts (F4)	34.59	23.21	270.50	(3.16)	0.00	0.40
Greenery & Roof (F5)	25.10	33.04	341.50	(2.02)	0.04	0.26
Re-development of Existing Sites & Brownfield Sites (F6)	25.52	32.61	336.50	(2.12)	0.03	0.27
Quality Assessment System in Construction (QLASSIC) (F7)	24.57	33.59	306.50	(2.55)	0.01	0.32
Regional Materials (F8)	34.36	23.45	303.50	(2.59)	0.01	0.33
Green Building Index Facilitator (F9)	33.33	24.52	311.00	(2.44)	0.01	0.31

**Only significant results of Mann-Whitney U-test are shown. Please refer to Appendix B for the complete results.*

From table 4.9, there were 9 criteria were found to be consist of significance difference between the respondents who have been involved in green building projects and the respondents who have not been involved in green building projects in the views of their level of difficulties in achieving the criteria.

From the table, those who have been involved in green building views were significantly different from those who were not on F4 (U=270.50, ρ=0.00, *r*=0.40) which their relationship of effect size had indicated a large or larger than typical strength of association. Those who never involved in green building project had scored a lower mean rank than those who had.

Those who have been involved in green building views were significantly different from those who were not on F1 (U=340.50, ρ=0.04, *r*=0.26), F2 (U=307.50, ρ=0.01, *r*=0.32), F5 (U=341.50, ρ=0.04, *r*=0.26) and F9 (U=311.00, ρ=0.01, *r*=0.31). Those who never involved in green building project had scored a lower mean rank than those who had. In addition with F3 (U=332.50, ρ=0.03, *r*=0.27), F6 (U=336.50, ρ=0.03, *r*=0.27), F7 (U=306.50, ρ=0.01, *r*=0.32), F8 (U=303.50, ρ=0.01, *r*=0.33) whereby those who have been involved in green building scored a lower mean rank than those who never. Generally, the effect size for the view of those who have been involved in green building and those who have not had indicated medium or typical strength of association.

4.2.3.3 Professions

Table 4.10: Comparison of GBI Criteria and Profession

Criteria	Mean Rank							Chi-Square	df	Asymp. Sig. (ρ)
	Architect	Contractor	Sub Contractor	Quantity Surveyor	M&E Engineer	Civil Engineer	Others			
Environmental Tobacco Smoke (ETS) Control	43.20	21.50	12.00	24.65	43.11	33.50	40.00	17.88	6	0.01
Integrated Pest Management, Erosion Control & Landscape Management	26.70	34.44	7.00	22.93	39.89	39.08	45.50	16.16	6	0.01
Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	48.20	21.22	9.00	24.46	41.54	36.00	38.00	18.61	6	0.00
Stormwater Design - Quality & Quantity Control	32.00	19.89	27.50	23.78	44.96	38.75	44.38	21.32	6	0.00
Green Building Index Facilitator	30.70	15.94	21.00	26.37	44.64	37.25	45.00	20.49	6	0.00

**Only significant results of Kruskal Wallis Tests are shown. Please refer to Appendix C for the complete results.*

From the 4.10, there are 5 criteria found to be consist of significance difference between the respondents who held a different profession in construction industry towards the views of their level of difficulties in achieving the criteria, which were thr ETS Control (ρ=0.04), Integrated Pest Management (ρ=0.04), Erosion Control & Landscape Management (ρ=0.04), Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle (ρ=0.04), Stormwater Design - Quality & Quantity Control (ρ=0.04), and GBIF (ρ=0.04). From the criteria, 3 of them under SM while the other 2 under IEQ and IN respectively. These criteria were then observed by the relationship among the view of the different professions.

Table 4.11: Comparison of GBI Criteria between Professions

Profession	Criteria	Mean Rank (1)	Mean Rank (2)	Mann-Whitney U (U)	*Z*	Asymp. Sig. (2-tailed) (ρ)	Effect Size (*r*)
(1) Architect & (2) Contractor	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	11.40	5.33	3.00	(2.69)	0.01	0.72
(1) Architect & (2) Quantity Surveyor	Environmental Tobacco Smoke (ETS) Control	21.50	12.98	22.50	(2.25)	0.02	0.43
	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	23.40	12.57	13.00	(2.75)	0.01	0.52
(1) Architect & (2) M&E Engineer	Integrated Pest Management, Erosion Control & Landscape Management	6.30	11.32	16.50	(1.94)	0.05	0.44
(1) Architect & (2) Others	Integrated Pest Management, Erosion Control & Landscape Management	3.40	7.00	2.00	(2.26)	0.02	0.75
(1) Contractor & (2) M&E Engineer	Environmental Tobacco Smoke (ETS) Control	8.06	14.54	27.50	(2.48)	0.01	0.52
	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	7.56	14.86	23.00	(2.61)	0.01	0.54
	Stormwater Design - Quality & Quantity Control	6.94	14.86	17.50	(2.99)	0.00	0.62
	Green Building Index Facilitator	5.61	16.11	5.50	(3.76)	0.00	0.78
(1) Contractor & (2) Civil Engineer	Stormwater Design - Quality & Quantity Control	6.17	10.75	10.50	(2.07)	0.04	0.54
	Green Building Index Facilitator	6.11	10.83	10.00	(2.07)	0.04	0.53
(1) Contractor & (2) Others	Stormwater Design - Quality & Quantity Control	5.50	10.38	4.50	(2.18)	0.03	0.60
	Green Building Index Facilitator	5.33	10.75	3.00	(2.41)	0.02	0.67

Profession	Criteria	Mean Rank (1)	Mean Rank (2)	Mann-Whitney U (U)	*Z*	Asymp. Sig. (2-tailed) (ρ)	Effect Size (*r*)
(1) Sub Contractor & (2) Others	Integrated Pest Management, Erosion Control & Landscape Management	1.00	3.50	-	(2.00)	0.05	0.89
(1) Quantity Surveyor & (2) M&E Engineer	Environmental Tobacco Smoke (ETS) Control	14.65	26.14	61.00	(3.31)	0.00	0.54
	Integrated Pest Management, Erosion Control & Landscape Management	15.13	25.36	72.00	(2.94)	0.00	0.48
	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	15.20	25.25	73.50	(2.82)	0.00	0.46
	Stormwater Design - Quality & Quantity Control	14.39	26.57	55.00	(3.49)	0.00	0.57
	Green Building Index Facilitator	14.78	25.93	64.00	(3.16)	0.00	0.52
(1) Quantity Surveyor & (2) Civil Engineer	Stormwater Design - Quality & Quantity Control	13.43	21.00	33.00	(2.08)	0.04	0.39
(1) Quantity Surveyor & (2) Others	Environmental Tobacco Smoke (ETS) Control	12.83	20.75	19.00	(2.05)	0.04	0.39
	Integrated Pest Management, Erosion Control & Landscape Management	12.61	22.00	14.00	(2.30)	0.02	0.44
	Stormwater Design - Quality & Quantity Control	12.65	21.75	15.00	(2.26)	0.02	0.43

**Only significant results of Mann-Whitney U-test are shown. Please refer to Appendix D for the complete results.*

Table 4.11 had indicated the pairs of respondents who hold different profession had significance difference towards the views of their level of difficulties in achieving the criteria. There were 5 criteria that has been taken into this test, i.e ETS Control (C1), Integrated Pest Management, Erosion Control & Landscape Management (C2), Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle (C3), Stormwater Design - Quality & Quantity Control (C4), and Green Building Index Facilitator (C5).

From the table above, it can be seen that the Quantity Surveyor and the M&E Engineer possessed significantly different view of level of difficulties in scoring the all 5 criteria as abovementioned, whereby the Quantity Surveyor consist of lower mean rank for all criteria than the M&E Engineer and the effect size among them are showing a much larger than typical strength of relationship. The significance difference level between them are C1 (U=61.00, ρ =0.00, r=0.54), C2 (U=72.00, ρ =0.00, r=0.48), C3 (U=73.50, ρ =0.00, r=0.46), C4 (U=55.00, ρ =0.00, r=0.57), and C5 (U=64.00, ρ =0.00, r=0.52).

The Contractor had attached differently towards his view of C4 with the M&E Engineer (U=17.50, ρ=0.01, r=0.62), Civil Engineer (U=10.50, ρ=0.04, r=0.54) and the other profession (U=4.50, ρ=0.03, r=0.60), whereby the Contractor has rate a lower mean rank as compared to them in all criteria. Besides, the Contractor also attached differently towards his view of C5 with the M&E Engineer (U=5.50, ρ=0.00, r=0.78), Civil Engineer (U=10.00, ρ=0.04, r=0.53) and the other professions (U=3.00, ρ=0.02, r=0.67). Again, the Contractor and the M&E Engineer had a significance difference in their view of C1 (U=27.50, ρ=0.01, r=0.52) and C3 (U=23.00, ρ=0.01, r=0.54), with the Contractor scored a lower mean rank. The effect size among them were showing a much larger than typical strength of relationship.

The Architect had shown his view towards the criteria's achievability is significantly different from most of the other groups. For C1, the Architect had a different view with Quantity Surveyor with a higher mean rank (21.50), U=22.50, ρ=0.02, r=0.43, the effect size of larger or larger than typical strength of relationship. In C2, the Architect has diverse view which scored a lower mean rank with the M&E Engineer (U=16.50, ρ=0.05, r=0.44) which its effect size shown larger or larger than typical strength of relationship and the other professions (U=2.00, ρ=0.02, r=0.75) with the effect size showing a much larger than typical strength of relationship. As for C3 the Architect has different view which scored a higher mean rank with the Contractor ($U=3.00$, $\rho=0.01$, $r=0.72$) and the Quantity Surveyor ($U=13.00$, $\rho=0.01$, $r=0.52$) with the effect size showing a much larger than typical strength of relationship for both party.

4.3 Discussion of Results

4.3.1 Energy Efficiency

EE was the category that deemed to be consisting less differences in the respondents' view and the building professionals do not consider it to be an issue in the implementation of GBI certification (Section 2.4.1). It was only perceived by the M&E Engineer to be the hardest category to achieve. Due to the proficiency of M&E Engineer in electrical industry, it is inevitable that he had greater tendency to concern more on energy related issue and had a greater understanding towards the complexity to the criteria.

Only Minimum EE Performance and Renewable Energy had been taken into account. The complexity of designing a building in compliance with minimum EE performance caused the construction personnel who lack of technical knowledge perceived that it was hard to achieve (Section 2.4.4.1 & Section 2.5.4). The incorporation of renewable energy was less favored by the respondents in general. The perception of the NGBIF that renewable energy can be achieved easily as compared to the GBIF might be due to there are many alternatives that available in the market. However, the GBIF had concerned on the practice in the industry and the technologies available in Malaysia (Section 4.4.1.2).

4.3.2 Indoor Environmental Quality

Among the six categories of GBI certification, IEQ was the easiest to achieve in whole population in the questionnaire survey. Those who shared this view are NGBIF and the Civil Engineer. The contractors group which involves both main and subcontractors were also concurred with the view. The nature of contractors business may lead to the view that IEQ is the easiest to achieve. The Contractor does not involved in designing work, therefore they will take the installation of devices as 'easy jobs'. Similarly conducting the verification work such as Post Occupancy Comfort Survey is also not a difficult task to go. As for the nature working environment for the Civil Engineer who mainly engaged on structural and external work barely involves neither the passive nor the active design approach for IEQ components, the unfamiliarity of the work scope might lead them to misperception that IEQ is easy to achieve.

ETS Control, Air Change Effectiveness and High Frequency Ballast consist of the difference views among the GBIF with NGBIF and those who involved in a green building project with none involvement in a green building project. ETS Control can be achieved by some simple procedure, somehow the practicability is doubted by the NGBIF and those who never involved in a green building project whether the occupants really comply with the instructions. the design for ETS Control approach would be easy for the Architects while additional cost incurred had become the concern of the Quantity Surveyors which this render a significance difference among them (Section 2.4.2.1). It was concerned by the actual achievability of Air Change Effectiveness due to the complexity of the system to be adopted (Section 2.4.2.2). High frequency ballasts provide comfort for the occupants, somehow the lifespan of the ballast might be vary due to the condition of usage for the lighting system and it is worried by the NGBIF and those who never involved in a green building project (Section 2.4.2.3).

4.3.3 Sustainable Site Planning and Management

The Quantity Surveyors deemed that SM was the hardest category to achieve. It is perhaps due to the criteria under this category it emphasized on the pre-construction and the management on stage such as the site selection, the site planning management, and the green allocation for the transportation. This criteria seems to increase the construction cost drastically and emphasize on the green construction while did not lead to patent reduction in the construction’s life cycle cost.

Building user manual is one of the criteria that deemed to be easily be achieved but there is an adverse view on the NGBIF that it is difficult to achieve. Printing of the manual has incurred additional cost, and the inconsistent in and outflow rate temporary occupants have caused the consecutive distribution of manual become difficult.

The Contractor attached a different view with other group of respondents especially with the M&E Engineer and Civil Engineer towards achieving the quality and quantity control of stormwater design. This criteria is apparently hard to achieve which perceived by the Contractor. As a contractor who mostly deal with coordinating the project, such requirement to produce a management plan in accordance with the Storm Water Management Manual for Malaysia (MSMA) might be rather sophisticated for them (Section 2.4.3.3). However, for the engineers who have been practicing professionally within their relevant fields, it can be no surprise that the engineers have been adopting the strategic incorporating into their normal projects. Besides, the Quantity Surveyors who have been emphasizing on cost might think that the initial cost would be largely induced by such planning while the payback is vague.

The groups of Architect with the groups of Quantity Surveyors had difference in their view of achieving the criteria of allocating priority parking spaces to the end users with green vehicle, i.e low emitting & fuel efficient vehicles. This is due to the Architect who mainly involved in the design stage has perceived that allocating the preferred parking spaces is easy by providing spaces and signage. However, the Quantity Surveyors might incur problems in terms of the evaluating the cost for value. In order to allocate the preferred carpark, extra spaces might be needed and hence lead to the reduction in overall usable area for construction. Also, the uncertainty of amount of the end users using the green vehicle might render to the abandonment to the parking spaces and insufficiency unit for the users with common vehicle. Green vehicle priority and both limited parking capacity allowed in a project is less favorable by the NGBIF due to the fact that green vehicle and public transport is not a primary medium for the public’s access.

Developing a brownfield site is never easy as there is too much consideration to be taken throughout the process and this is noticed by the GBIF (Section 2.4.3.2). The Architect perceived that the Integrated Pest Management, Erosion Control & Landscape Management is harder to achieve as compare to other profession. Such concern to the external environment is always the least concern towards the specialty of Architect in designing a state-of-art building and he is barely furnished with the knowledge regarding to that (Section 2.4.3.1 & Section 2.5.4). For those who never involved in a green building project, it can be said that they rarely adopt such system in a construction project and therefore there is lack of awareness to this programme. Obtaining the QLASSIC is said to be uneconomical to some respondents as its compliance only scores one point in the overall GBI certification (Section 1.4.3.4, Section 2.5.1 & Section 2.5.4).

4.3.4 Materials and Resources

Among the six categories of GBI certification, MR was the most difficult to achieve. Those who possessed better knowledge or experiences in green building such as the GBIF and Architect, view that MR was the hardest category to achieve. MR involves with utilization of regional materials. It is inevitable that the regional materials might be perceived to be hard to obtain. Even sourcing a regional material would said to be reduce the transportation cost and preserve the environment, the common practice of the construction has become the impediment to adopt the regional materials as a mean of materials supply as the perception of obtaining materials from overseas in bulk is cheaper. The Architect who lack of information would be difficult for him in justifying the materials (Section 2.4.4.1).

4.3.5 Water Efficiency

The Architect and the Quantity Surveyors assented that WE is the easiest to achieve. Quantity Surveyors have dealt with the issue relevant with cost in a project most of the time. Therefore, for them pricing would be the major concern in the practice. The compliance to the WE category would incur lesser cost as compared to other category, such as the water efficient fittings. The Architect finds that the compliance of WE can be achieved with the installation of the water efficient fittings in the building.

Under WE, Water Recycling and Metering & Leak Detection System is found that there is a differences view attached to the GBIF and NGBIF. Water recycling is one of the elements which can be achieved easily by installing water recycling system. However, the GBIF have realized the hidden agenda in achieving this criterion. The initial cost to implement water recycling system is high due to a precise system is required while the payback would not be significant as the water charges in Malaysia itself is rather inexpensive. Besides that, the uncommitted behavior of the end users might render this system to be inutile due to their doubt is the usability of the recycled water (Section 1.4.5.1). Water sub-metering is not common in the local practice and the NGBIF has concurred that water leakage is one of the component that incurred extra cost while provide no benefit to the developer as the overall cost they have to paid (Section 2.5.1).

4.3.6 Innovation

IN is a category that plays a significant role in the analysis, as the GBI and the NGBIF has extreme views towards its achievability. The GBIF and the M&E have expressed their view that IN is the easiest to achieve. Meanwhile, the NGBIF and the groups of contractors which are the main and subcontractors believed that IN is the hardest to achieve. The criterion of appointing a GBI Facilitator has lead to major adverse views between the groups. It can be convinced that the gist is due to the IN category consist of the criteria to engage a GBIF in the construction project acting as a green consultant. The GBIF, themselves who are being one of it, tend to perceive that getting GBIF to engage in a construction project will never cause problem. However, the NGBIF such as the contractor would perceive that there are fewer amount of the GBIF might be hard for them to appoint one in the project. Also, the appointment fees might be a burden for the key personnel to appoint the GBIF in the project. The building consultants who play the same role as GBIF have the same view with the GBIF in the achievability of IN category (Section 1.4.6.1). However, the appointment of the GBIF in a green building project is the fifth criteria that deemed to be the easiest to achieve.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter reflected the research findings by review of aims and objectives, as well the implications towards the construction industry, the government sector and academic sector. Also, it will outline the limitations encountered in this research and recommendations will be given for further improvement.

5.2 Summary of Findings

This research set out to find out the perception of building professionals towards the criteria obtained in Green Building Index (GBI) guidelines which to be fulfilled in the application of GBI certification. Through this research, the overall indices have shown that the professions in construction industry have shown a rather positive feedback towards the achievability of the project especially the Architect, GBIF and GBP can be used to represent to the overview of the achievability of the criteria in GBI guidelines. The groups of Quantity Surveyors and Contractors have some perceived that the GBI criteria are harder to achieve (Research Objectives 1).

It was shown that the differences in such perception was due to the nature of work scope in the construction industry, The Architect focus on design planning who involved in pre-construction stage, the Quantity Surveyors have concern over optimization of cost, the contractors who mainly dealt with the installation of components and coordinating the progress of project and the engineers who are being the specialist in specific areas. The reason that has become the impediment to the implementation of the criteria are due to the specialization of the profession has led to the lack of education towards the green specifications. As a result of lack of technical understanding, the green strategy has perceived to be more complex than it is and thus the profession will refuse to apply. Perception of higher upfront cost had prohibited the application as the initial construction cost will always be emphasized rather than life cycle cost. Insufficient source of the green component and thereafter lack of information needed no doubt has led to the reluctance of profession to apply green strategy (Research Objectives 2).

IEQ shall be deemed to be the category that is easiest to achieve among all. Hence, the considerations of IEQ element can also be scrutinized ahead of other category to score as much as they could in lowest payout. Among the 6 categories in GBI guidelines, the category of sustainable site planning and management induced a relatively significance differences in the views of different building professions (Research Objectives 3).

In this study, the 20 criteria that are deemed to be achieved in least barriers as followed, which is Environmental Tobacco Smoke (ETS), Control Electric Lighting Levels, Sound Insulation, Lighting Zoning, Green Building Index Facilitator, Water Efficient Fittings, Daylight Glare Control, Parking Capacity, Building User Manual, Daylighting, High Frequency Ballasts, Home Office & Connectivity Thermal Comfort: Design & Controllability of Systems, Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle, Minimum Indoor Air Quality Performance, Storage, Collection & Disposal of Recyclables, Electrical Sub-metering, Internal Noise Levels, External Views, and Rainwater Harvesting (Research Objectives 4).

5.3 Implications

This research has set out a guideline for the industry and serves as a basis for the applicants can focus on the criteria that deemed to be easily achieved. The reasons of the criteria that become a major setback for the GBI certifications can be used by the industry as a reference to identify a suitable solution to mitigate such perception of difficulties. Besides, the differences view possessed by the different professions can be identified. With that, the building professions can have a cross understanding among each other while this will enhance the communication among them and contribute to the reduction in disputes and arguments. As a result, it will definitely help to facilitate the construction work as well the application of GBI strategy to be carried out.

In addition, this research has an implication towards the government sector as well. Through this research, it can be said that insufficient source of green supply has become one of the impediments for the green strategy. In this scenario, the government can contribute by stimulating the green market and introducing more green products from the foreign country. Besides, the government can further promote the green fiscal policy for the developers who seek for the instant construction cost reduction after the additional initial cost for green strategy application. More training shall be initiated by the government party to furnish the building professions.

As for the academic sector, this research can be set as a baseline to furnish the people with the insight view of specific criteria that the public has possessed a misperception towards it, in order to enable the public to have the understanding towards the criteria and lessen the confusion in them.

5.4 Limitations and Recommendations

This research is generally obtained from an overview of the perceptions of different professions on the GBI certification emphasizing the achievability the criteria required in the application. Due to the vast amount of the criteria included, the views of the professions could be diversified and could lead to confusion easily. Besides, the distribution of questionnaires was adopting the simple random sampling, whereby there were uneven distributions of groups of sample. It can cause the results to be bias to particular groups of sample and fail to prove differences in certain criteria. Furthermore, this research did not investigate in each of the criteria in details and find out the inherent problem. As a result, the problem could not be identified thoroughly.

An in depth study could be done to focus on specific groups of profession of their perception towards the GBI criteria. Further research can be done to investigate on certain category of GBI tools as to enable a comprehensive study can be carried out. This is to enable the respondent to focus on such area to express their views and have an insight analysis towards each of the category accordingly. Besides, further research could be done on with the evenly distributed samples. A research should be done by focus on the barriers of GBI implementation. In addition, the research should focus on judgment sample who possess a certain degree of experience and knowledge on green strategy to provide more reliable information rather than the mere perception possessed by the professions.

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APPENDICES

APPENDIX A: Table for Comparison of GBI Criteria between GBI Facilitators and Non GBI Facilitators

Criteria	Mean Rank		Mann-Whitney U (U)	*Z*	Asymp. Sig. (2-tailed) (ρ)	Effect Size (*r*)
	Yes	No				
Minimum Energy Efficient (EE) Performance	35.58	25.45	326.50	(1.97)	0.05	0.25
Lighting Zoning	34.95	25.78	342.00	(1.78)	0.07	0.23
Electrical Sub-metering	32.68	27.01	341.50	(1.79)	0.07	0.23
Advanced EE Performance based on Overall Thermal Transfer Value(OTTV)	30.03	28.45	450.00	(0.09)	0.93	0.01
Advanced EE Performance based on Roof Thermal Transfer Value (RTTV)	31.65	27.57	412.00	(0.67)	0.50	0.09
Home Office & Connectivity	32.48	27.12	378.00	(1.18)	0.24	0.15
Renewable Energy	19.20	34.30	219.00	(3.51)	0.00	0.45
Advanced or Improved EE Performance Building Energy Intensity (BEI)	27.43	29.85	446.50	(0.15)	0.88	0.02
Enhanced Commissioning	28.70	29.16	434.00	(0.35)	0.73	0.04
On-going Post Occupancy Commissioning	31.55	27.62	386.00	(1.07)	0.28	0.14
Energy Efficiency Verification	29.93	28.50	428.00	(0.42)	0.67	0.05
Sustainable Maintenance	29.55	28.70	429.00	(0.41)	0.68	0.05
Minimum Indoor Air Quality Performance	31.28	27.77	411.00	(0.70)	0.48	0.09
Environmental Tobacco Smoke (ETS) Control	39.30	23.43	225.50	(3.51)	0.00	0.45

Criteria	Mean Rank		Mann-Whitney U (U)	Z	Asymp. Sig. (2-tailed) (ρ)	Effect Size (r)
	Yes	No				
Sound Insulation	27.65	29.73	375.50	(1.27)	0.21	0.16
Good Quality Construction	26.85	30.16	384.00	(1.10)	0.27	0.14
Carbon Dioxide Monitoring and Control	30.40	28.24	404.00	(0.79)	0.43	0.10
Indoor Air Pollutant & Industrial Chemical Exposure	23.83	31.80	332.50	(1.89)	0.06	0.24
Mould Prevention	25.95	30.65	377.00	(1.25)	0.21	0.16
Thermal Comfort: Design & Controllability of Systems	30.43	28.23	432.00	(0.37)	0.71	0.05
Air Change Effectiveness	22.20	32.68	292.00	(2.48)	0.01	0.32
Breakout Spaces	33.38	26.64	361.00	(1.48)	0.14	0.19
Daylighting	23.75	31.84	354.50	(1.57)	0.12	0.20
Daylight Glare Control	26.45	30.38	407.50	(0.77)	0.44	0.10
Electric Lighting Levels	31.55	27.62	384.50	(1.14)	0.25	0.14
High Frequency Ballasts	37.80	24.24	231.50	(3.50)	0.00	0.44
External Views	30.53	28.18	447.50	(0.13)	0.90	0.02
Internal Noise Levels	32.05	27.35	421.50	(0.53)	0.60	0.07
IAQ Before & During Occupancy	32.70	27.00	389.50	(1.03)	0.30	0.13
Post Occupancy Comfort Survey: Verification	37.43	24.45	308.50	(2.29)	0.02	0.29
GBI Rated Design & Construction	30.73	28.07	438.50	(0.27)	0.78	0.03
Building Exterior Management	29.53	28.72	427.00	(0.45)	0.65	0.06
Integrated Pest Management, Erosion Control & Landscape Management	33.48	26.58	370.00	(1.33)	0.18	0.17
Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	43.30	21.27	130.00	(4.86)	0.00	0.62
Parking Capacity	38.23	24.01	246.50	(3.14)	0.00	0.40
Greenery & Roof	24.38	31.50	363.50	(1.39)	0.16	0.18
Building User Manual	38.15	24.05	241.00	(3.22)	0.00	0.41
Open Spaces, Landscaping & Heat Island Effect	33.30	26.68	343.50	(1.68)	0.09	0.21
Re-development of Existing Sites & Brownfield Sites	19.98	33.88	260.00	(2.99)	0.00	0.38
Avoiding Environmentally Sensitive Areas	29.05	28.97	424.50	(0.48)	0.63	0.06
Development Density & Community Connectivity	27.55	29.78	427.50	(0.45)	0.66	0.06
Environment Management	26.95	30.11	399.50	(0.89)	0.37	0.11

Criteria	Mean Rank		Mann-Whitney U (U)	*Z*	Asymp. Sig. (2-tailed) (ρ)	Effect Size (*r*)
	Yes	No				
Noise Pollution	32.60	27.05	394.50	(0.98)	0.33	0.12
Quality Assessment System in Construction (QLASSIC)	28.30	29.38	421.00	(0.53)	0.59	0.07
Workers' Site Amenities	33.93	26.34	383.00	(1.13)	0.26	0.14
Public Transportation Access & Transportation Plan	24.50	31.43	338.50	(1.82)	0.07	0.23
Cargo Delivery Route and Proximity	31.10	27.86	399.50	(0.90)	0.37	0.11
Stormwater Design - Quality & Quantity Control	35.83	25.31	313.50	(2.19)	0.03	0.28
Materials Reuse and Selection	24.58	31.39	362.00	(1.41)	0.16	0.18
Recycled Content Materials	24.65	31.35	352.00	(1.59)	0.11	0.20
Sustainable Timber	28.55	29.24	439.50	(0.25)	0.80	0.03
Regional Materials	34.95	25.78	323.50	(2.01)	0.04	0.25
Sustainable Purchasing Policy	29.35	28.81	447.00	(0.14)	0.89	0.02
Storage, Collection & Disposal of Recyclables	28.20	29.43	423.00	(0.50)	0.62	0.06
Refrigerants & Clean Agents	33.53	26.55	365.00	(1.39)	0.16	0.18
Construction Waste Management	28.08	29.50	448.50	(0.11)	0.91	0.01
Rainwater Harvesting	25.28	31.01	379.00	(1.17)	0.24	0.15
Water Recycling	22.45	32.54	286.50	(2.55)	0.01	0.32
Water Efficient Irrigation/Landscaping	29.13	28.93	449.00	(0.11)	0.91	0.01
Water Efficient Fittings	33.10	26.78	356.00	(1.56)	0.12	0.20
Metering & Leak Detection System	36.38	25.01	295.50	(2.42)	0.02	0.31
Innovation & Environmental Design Initiatives	31.75	27.51	371.50	(1.28)	0.20	0.16
Green Building Index Facilitator	41.23	22.39	168.50	(4.29)	0.00	0.55

APPENDIX B: Table for Comparison of GBI Criteria between the Groups of Involvement in Green Building Project

Criteria	Mean Rank		Mann-Whitney U (U)	*Z*	Asymp. Sig. (2-tailed) (ρ)	Effect Size (*r*)
	Yes	No				
Minimum Energy Efficient (EE) Performance	31.90	26.00	401.50	(1.15)	0.25	0.15
Lighting Zoning	30.95	26.98	446.50	(0.49)	0.63	0.06
Electrical Sub-metering	31.19	26.73	404.00	(1.14)	0.26	0.14
Advanced EE Performance based on Overall Thermal Transfer Value(OTTV)	29.29	28.70	477.00	(0.02)	0.98	0.00
Advanced EE Performance based on Roof Thermal Transfer Value (RTTV)	28.83	29.18	476.50	(0.03)	0.98	0.00
Home Office & Connectivity	33.93	23.89	340.50	(2.05)	0.04	0.26
Renewable Energy	26.19	31.91	371.50	(1.55)	0.12	0.20
Advanced or Improved EE Performance Building Energy Intensity (BEI)	28.83	29.18	462.50	(0.24)	0.81	0.03
Enhanced Commissioning	27.34	30.71	447.50	(0.47)	0.63	0.06
On-going Post Occupancy Commissioning	28.91	29.09	464.50	(0.21)	0.83	0.03
Energy Efficiency Verification	30.86	27.07	426.00	(0.78)	0.44	0.10
Sustainable Maintenance	31.76	26.14	369.00	(1.61)	0.11	0.20
Minimum Indoor Air Quality Performance	30.86	27.07	402.00	(1.16)	0.25	0.15
Environmental Tobacco Smoke (ETS) Control	32.83	25.04	307.50	(2.54)	0.01	0.32
Sound Insulation	30.14	27.82	457.00	(0.33)	0.74	0.04
Good Quality Construction	28.28	29.75	441.00	(0.56)	0.58	0.07
Carbon Dioxide Monitoring and Control	31.10	26.82	379.50	(1.47)	0.14	0.19
Indoor Air Pollutant & Industrial Chemical Exposure	27.29	30.77	402.00	(1.14)	0.25	0.15
Mould Prevention	27.09	30.98	410.00	(1.06)	0.29	0.13

Criteria	Mean Rank		Mann-Whitney U (U)	*Z*	Asymp. Sig. (2-tailed) (ρ)	Effect Size (*r*)
	Yes	No				
Thermal Comfort: Design & Controllability of Systems	30.64	27.30	454.00	(0.37)	0.71	0.05
Air Change Effectiveness	25.43	32.70	332.50	(2.16)	0.03	0.27
Breakout Spaces	30.28	27.68	418.50	(0.91)	0.36	0.12
Daylighting	26.43	31.66	376.00	(1.55)	0.12	0.20
Daylight Glare Control	28.02	30.02	425.50	(0.82)	0.41	0.10
Electric Lighting Levels	31.29	26.63	412.50	(1.03)	0.30	0.13
High Frequency Ballasts	34.59	23.21	270.50	(3.16)	0.00	0.40
External Views	28.34	29.68	428.00	(0.75)	0.45	0.10
Internal Noise Levels	28.72	29.29	464.50	(0.21)	0.83	0.03
IAQ Before & During Occupancy	26.33	31.77	381.50	(1.47)	0.14	0.19
Post Occupancy Comfort Survey: Verification	30.59	27.36	453.50	(0.38)	0.70	0.05
GBI Rated Design & Construction	28.62	29.39	451.50	(0.41)	0.68	0.05
Building Exterior Management	28.36	29.66	450.50	(0.43)	0.67	0.05
Integrated Pest Management, Erosion Control & Landscape Management	29.79	28.18	443.00	(0.54)	0.59	0.07
Green Vehicle Priority -Low Emitting & Fuel Efficient Vehicle	32.02	25.88	377.50	(1.47)	0.14	0.19
Parking Capacity	32.14	25.75	358.50	(1.76)	0.08	0.22
Greenery & Roof	25.10	33.04	341.50	(2.02)	0.04	0.26
Building User Manual	31.71	26.20	406.00	(1.06)	0.29	0.13
Open Spaces, Landscaping & Heat Island Effect	28.31	29.71	441.00	(0.55)	0.58	0.07
Re-development of Existing Sites & Brownfield Sites	25.52	32.61	336.50	(2.12)	0.03	0.27
Avoiding Environmentally Sensitive Areas	27.14	30.93	392.00	(1.29)	0.20	0.16
Development Density & Community Connectivity	30.74	27.20	421.00	(0.88)	0.38	0.11
Environment Management	28.34	29.68	450.50	(0.43)	0.67	0.05
Noise Pollution	29.24	28.75	474.00	(0.07)	0.94	0.01
Quality Assessment System in Construction (QLASSIC)	24.57	33.59	306.50	(2.55)	0.01	0.32
Workers' Site Amenities	30.48	27.46	419.00	(0.90)	0.37	0.11
Public Transportation Access & Transportation Plan	29.76	28.21	466.50	(0.18)	0.86	0.02

Criteria	Mean Rank		Mann-Whitney U (U)	*Z*	Asymp. Sig. (2-tailed) (ρ)	Effect Size (*r*)
	Yes	No				
Cargo Delivery Route and Proximity	29.48	28.50	473.00	(0.09)	0.93	0.01
Stormwater Design Ċ Quality & Quantity Control	27.57	30.48	455.00	(0.35)	0.72	0.04
Materials Reuse and Selection	27.31	30.75	430.00	(0.71)	0.48	0.09
Recycled Content Materials	28.97	29.04	474.00	(0.07)	0.95	0.01
Sustainable Timber	30.17	27.79	428.00	(0.74)	0.46	0.09
Regional Materials	34.36	23.45	303.50	(2.59)	0.01	0.33
Sustainable Purchasing Policy	25.47	32.66	365.50	(1.72)	0.09	0.22
Storage, Collection & Disposal of Recyclables	29.62	28.36	451.50	(0.40)	0.69	0.05
Refrigerants & Clean Agents	32.12	25.77	365.50	(1.69)	0.09	0.21
Construction Waste Management	29.34	28.64	471.00	(0.11)	0.91	0.01
Rainwater Harvesting	27.84	30.20	447.50	(0.46)	0.65	0.06
Water Recycling	26.62	31.46	363.50	(1.69)	0.09	0.21
Water Efficient Irrigation/Landscaping	29.88	28.09	428.50	(0.74)	0.46	0.09
Water Efficient Fittings	30.05	27.91	422.00	(0.86)	0.39	0.11
Metering & Leak Detection System	30.93	27.00	390.50	(1.29)	0.20	0.16
Innovation & Environmental Design Initiatives	27.79	30.25	443.00	(0.52)	0.60	0.07
Green Building Index Facilitator	33.33	24.52	311.00	(2.44)	0.01	0.31

APPENDIX C : Table for Comparison of GBI Criteria and Profession

Criteria	Mean Rank							Chi-Square	df	Asymp. Sig. (ρ)
	Architect	Contractor	Sub Contractor	Quantity Surveyor	M&E Engineer	Civil Engineer	Others			
Minimum Energy Efficient (EE) Performance	30.70	32.89	49.00	27.20	32.11	37.17	39.13	4.05	6	0.67
Lighting Zoning	25.80	23.72	14.50	33.00	37.68	30.17	32.13	5.73	6	0.45
Electrical Sub-metering	28.90	30.22	19.50	28.22	34.32	42.00	33.88	4.45	6	0.62
Advanced EE Performance based on Overall Thermal Transfer Value(OTTV)	25.50	35.67	36.00	32.15	31.18	28.00	31.13	1.57	6	0.95
Advanced EE Performance based on Roof Thermal Transfer Value (RTTV)	29.20	32.06	28.00	30.50	32.71	25.25	44.88	3.57	6	0.73
Home Office & Connectivity	28.30	35.94	41.50	27.41	31.50	29.50	49.50	6.90	6	0.33
Renewable Energy	23.90	44.06	49.50	34.50	24.64	25.33	24.25	10.78	6	0.10
Advanced or Improved EE Performance - Building Energy Intensity (BEI)	22.00	39.94	15.50	33.37	29.57	27.00	31.13	5.52	6	0.48
Enhanced Commissioning	20.30	36.28	30.50	30.85	38.93	24.50	23.25	7.91	6	0.25
On-going Post Occupancy Commissioning	24.80	32.56	28.50	31.09	34.18	25.92	39.63	2.75	6	0.84
Energy Efficiency Verification	30.30	32.22	25.50	29.85	36.32	24.00	36.75	2.99	6	0.81
Sustainable Maintenance	31.80	32.67	10.00	26.33	39.61	30.17	37.25	7.15	6	0.31

Criteria	Mean Rank							Chi-Square	df	Asymp. Sig. (ρ)
	Architect	Contractor	Sub Contractor	Quantity Surveyor	M&E Engineer	Civil Engineer	Others			
Minimum Indoor Air Quality Performance	30.60	35.33	5.00	24.30	37.07	41.83	37.00	11.45	6	0.08
Environmental Tobacco Smoke (ETS) Control	43.20	21.50	12.00	24.65	43.11	33.50	40.00	17.88	6	0.01
Sound Insulation	19.80	31.56	35.50	33.41	29.57	31.42	40.88	4.32	6	0.63
Good Quality Construction	31.00	34.61	49.00	30.57	28.46	34.33	32.50	2.05	6	0.92
Carbon Dioxide Monitoring and Control	29.00	22.39	24.50	29.15	43.46	33.08	26.13	10.54	6	0.10
Indoor Air Pollutant & Industrial Chemical Exposure	25.70	35.50	30.00	32.57	33.46	29.92	19.50	3.40	6	0.76
Mould Prevention	17.60	36.39	27.00	31.57	28.79	35.50	42.13	6.84	6	0.34
Thermal Comfort: Design & Controllability of Systems	15.20	30.67	43.00	29.96	38.50	30.50	36.75	8.33	6	0.21
Air Change Effectiveness	21.70	36.39	49.50	34.98	28.29	29.17	23.00	5.95	6	0.43
Breakout Spaces	28.50	29.06	28.50	30.59	37.46	21.92	40.25	5.30	6	0.51
Daylighting	23.70	38.00	17.00	37.09	27.07	25.17	23.13	8.53	6	0.20
Daylight Glare Control	21.10	35.00	39.00	33.70	25.25	34.83	39.00	6.08	6	0.41
Electric Lighting Levels	18.40	28.28	34.50	28.96	36.93	38.08	40.13	7.79	6	0.25
High Frequency Ballasts	25.20	24.44	43.50	28.09	37.75	35.08	44.63	8.46	6	0.21
External Views	29.80	33.72	22.50	32.87	30.68	30.00	28.13	0.86	6	0.99
Internal Noise Levels	14.60	26.11	21.00	30.80	40.39	32.58	38.63	10.83	6	0.09
IAQ Before & During Occupancy	34.00	24.00	31.50	32.61	31.71	25.17	47.63	6.57	6	0.36
Post Occupancy Comfort Survey: Verification	28.50	28.50	7.00	30.78	32.07	33.67	47.00	6.13	6	0.41

Criteria	Mean Rank							Chi-Square	df	Asymp. Sig. (ρ)
	Architect	Contractor	Sub Contractor	Quantity Surveyor	M&E Engineer	Civil Engineer	Others			
GBI Rated Design & Construction	21.90	21.17	27.00	32.96	40.86	27.50	32.75	10.10	6	0.12
Building Exterior Management	27.20	39.33	22.00	25.35	37.54	27.75	41.50	9.40	6	0.15
Integrated Pest Management, Erosion Control & Landscape Management	26.70	34.44	7.00	22.93	39.89	39.08	45.50	16.16	6	0.01
Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	48.20	21.22	9.00	24.46	41.54	36.00	38.00	18.61	6	-
Parking Capacity	41.40	23.00	6.50	27.17	38.46	30.42	46.63	12.56	6	0.05
Greenery & Roof	29.00	32.67	24.00	32.24	32.89	28.17	29.75	0.73	6	0.99
Building User Manual	28.10	27.11	20.50	27.00	35.46	38.08	50.50	9.07	6	0.17
Open Spaces, Landscaping & Heat Island Effect	36.40	32.89	9.50	27.28	33.71	32.67	42.50	5.25	6	0.51
Re-development of Existing Sites & Brownfield Sites	12.70	39.28	23.50	36.72	27.64	30.83	24.00	11.78	6	0.07
Avoiding Environmentally Sensitive Areas	23.00	28.61	36.50	32.91	32.57	31.67	35.25	1.99	6	0.92
Development Density & Community Connectivity	26.70	34.39	33.00	33.17	29.11	25.50	38.38	2.67	6	0.85
Environment Management	25.30	31.22	24.00	31.35	35.86	25.08	37.00	3.25	6	0.78
Noise Pollution	33.80	19.17	29.00	33.43	35.57	29.25	35.00	6.68	6	0.35
Quality Assessment System in Construction (QLASSIC)	21.00	28.61	51.00	33.43	30.11	34.25	35.88	4.22	6	0.65
Workers' Site Amenities	29.60	26.17	5.50	27.61	40.86	38.42	31.63	9.90	6	0.13
Public Transportation Access & Transportation Plan	23.20	31.06	7.50	32.46	35.39	32.17	28.75	4.21	6	0.65

Criteria	Mean Rank							Chi-Square	df	Asymp. Sig. (ρ)
	Architect	Contractor	Sub Contractor	Quantity Surveyor	M&E Engineer	Civil Engineer	Others			
Cargo Delivery Route and Proximity	41.20	25.89	8.50	29.87	32.39	31.83	43.50	7.16	6	0.31
Stormwater Design - Quality & Quantity Control	32.00	19.89	27.50	23.78	44.96	38.75	44.38	21.32	6	-
Materials Reuse and Selection	26.60	25.17	37.00	36.46	34.21	27.25	18.88	6.40	6	0.38
Recycled Content Materials	24.00	25.83	38.00	36.57	29.71	26.67	36.38	5.07	6	0.54
Sustainable Timber	22.00	28.11	34.00	35.83	28.07	30.75	38.63	4.54	6	0.60
Regional Materials	31.60	27.89	8.00	30.24	38.93	31.67	26.38	5.34	6	0.50
Sustainable Purchasing Policy	32.00	28.56	32.00	29.93	40.14	28.25	21.00	6.03	6	0.42
Storage, Collection & Disposal of Recyclables	23.30	27.22	22.50	32.22	39.39	28.92	25.75	5.46	6	0.49
Refrigerants & Clean Agents	19.60	25.56	24.00	31.26	37.18	32.75	41.25	6.62	6	0.36
Construction Waste Management	22.70	33.06	28.00	31.04	38.89	25.08	26.25	5.18	6	0.52
Rainwater Harvesting	26.60	30.83	22.50	35.37	36.75	18.50	20.25	8.30	6	0.22
Water Recycling	23.10	37.06	48.00	35.74	25.57	26.83	28.75	6.54	6	0.36
Water Efficient Irrigation/Landscaping	33.60	27.22	23.50	30.43	41.57	28.17	16.38	9.18	6	0.16
Water Efficient Fittings	34.50	23.94	16.50	31.59	40.54	25.83	24.88	8.21	6	0.22
Metering & Leak Detection System	43.50	21.83	24.50	29.20	41.71	23.08	30.13	12.08	6	0.06
Innovation & Environmental Design Initiatives	28.30	30.00	10.50	29.63	42.07	23.33	30.13	8.60	6	0.20
Green Building Index Facilitator	30.70	15.94	21.00	26.37	44.64	37.25	45.00	20.49	6	-

APPENDIX D : Table for Comparison of GBI Criteria between Professions

Profession		Mean Rank (1)	Mean Rank (2)	Mann-Whitney U (U)	*Z*	Asymp. Sig. (2-tailed) (ρ)	Effect Size (*r*)
(1) Architect & (2) Contractor	Environmental Tobacco Smoke (ETS) Control	10.20	6.00	9.00	(1.89)	0.06	0.50
	Integrated Pest Management, Erosion Control & Landscape Management	6.20	8.22	16.00	(0.95)	0.34	0.25
	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	11.40	5.33	3.00	(2.69)	0.01	0.72
	Stormwater Design - Quality & Quantity Control	9.50	6.39	12.50	(1.48)	0.14	0.40
	Green Building Index Facilitator	9.90	6.17	10.50	(1.66)	0.10	0.44
(1) Architect & (2) Sub Contractor	Environmental Tobacco Smoke (ETS) Control	3.90	1.50	0.50	(1.41)	0.16	0.58
	Integrated Pest Management, Erosion Control & Landscape Management	4.00	1.00	-	(1.73)	0.08	0.71
	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	4.00	1.00	-	(1.58)	0.11	0.65
	Stormwater Design - Quality & Quantity Control	3.60	3.00	2.00	(0.45)	0.65	0.18
	Green Building Index Facilitator	3.70	2.50	1.50	(0.60)	0.55	0.25

Profession		Mean Rank (1)	Mean Rank (2)	Mann-Whitney U (U)	*Z*	Asymp. Sig. (2-tailed) (ρ)	Effect Size (*r*)
(1) Architect &(2) Quantity Surveyor	Environmental Tobacco Smoke (ETS) Control	21.50	12.98	22.50	(2.25)	0.02	0.43
	Integrated Pest Management, Erosion Control & Landscape Management	17.30	13.89	43.50	(0.90)	0.37	0.17
	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	23.40	12.57	13.00	(2.75)	0.01	0.52
	Stormwater Design - Quality & Quantity Control	18.40	13.65	38.00	(1.28)	0.20	0.24
	Green Building Index Facilitator	16.30	14.11	48.50	(0.56)	0.58	0.11
(1) Architect & (2) M&E Engineer	Environmental Tobacco Smoke (ETS) Control	10.10	9.96	34.50	(0.06)	0.95	0.01
	Integrated Pest Management, Erosion Control & Landscape Management	6.30	11.32	16.50	(1.94)	0.05	0.44
	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	11.30	9.54	28.50	(0.66)	0.51	0.15
	Stormwater Design - Quality & Quantity Control	6.50	11.25	17.50	(1.75)	0.08	0.40
	Green Building Index Facilitator	6.50	11.25	17.50	(1.76)	0.08	0.40
(1) Architect & (2) Civil Engineer	Environmental Tobacco Smoke (ETS) Control	7.10	5.08	9.50	(1.11)	0.27	0.33
	Integrated Pest Management, Erosion Control & Landscape Management	4.50	7.25	7.50	(1.54)	0.12	0.46
	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	7.50	4.75	7.50	(1.54)	0.12	0.46
	Stormwater Design - Quality & Quantity Control	5.10	6.75	10.50	(0.98)	0.33	0.30
	Green Building Index Facilitator	5.30	6.58	11.50	(0.66)	0.51	0.20

Profession		Mean Rank (1)	Mean Rank (2)	Mann-Whitney U (U)	*Z*	Asymp. Sig. (2-tailed) (ρ)	Effect Size (*r*)
(1) Architect & (2) Others	Environmental Tobacco Smoke (ETS) Control	5.40	4.50	8.00	(0.59)	0.56	0.20
	Integrated Pest Management, Erosion Control & Landscape Management	3.40	7.00	2.00	(2.26)	0.02	0.75
	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	5.60	4.25	7.00	(0.81)	0.42	0.27
	Stormwater Design - Quality & Quantity Control	3.90	6.38	4.50	(1.56)	0.12	0.52
	Green Building Index Facilitator	4.00	6.25	5.00	(1.29)	0.20	0.43
(1) Contractor & (2) Sub Contractor	Environmental Tobacco Smoke (ETS) Control	5.56	5.00	4.00	(0.18)	0.86	0.06
	Integrated Pest Management, Erosion Control & Landscape Management	5.89	2.00	1.00	(1.27)	0.20	0.40
	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	5.72	3.50	2.50	(0.72)	0.47	0.23
	Stormwater Design - Quality & Quantity Control	5.33	7.00	3.00	(0.56)	0.57	0.18
	Green Building Index Facilitator	5.33	7.00	3.00	(0.56)	0.57	0.18
(1) Contractor & (2) Quantity Surveyor	Environmental Tobacco Smoke (ETS) Control	14.22	17.39	83.00	(0.92)	0.36	0.16
	Integrated Pest Management, Erosion Control & Landscape Management	20.50	14.93	67.50	(1.58)	0.11	0.28
	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	15.22	17.00	92.00	(0.50)	0.62	0.09
	Stormwater Design - Quality & Quantity Control	14.56	17.26	86.00	(0.79)	0.43	0.14
	Green Building Index Facilitator	12.39	18.11	66.50	(1.61)	0.11	0.28

Profession		Mean Rank (1)	Mean Rank (2)	Mann-Whitney U (U)	*Z*	Asymp. Sig. (2-tailed) (ρ)	Effect Size (*r*)
(1) Contractor & (2) M&E Engineer	Environmental Tobacco Smoke (ETS) Control	8.06	14.54	27.50	(2.48)	0.01	0.52
	Integrated Pest Management, Erosion Control & Landscape Management	10.94	12.68	53.50	(0.67)	0.50	0.14
	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	7.56	14.86	23.00	(2.61)	0.01	0.54
	Stormwater Design - Quality & Quantity Control	6.94	14.86	17.50	(2.99)	0.00	0.62
	Green Building Index Facilitator	5.61	16.11	5.50	(3.76)	0.00	0.78
(1) Contractor & (2) Civil Engineer	Environmental Tobacco Smoke (ETS) Control	6.78	9.83	16.00	(1.34)	0.18	0.35
	Integrated Pest Management, Erosion Control & Landscape Management	7.56	8.67	23.00	(0.53)	0.59	0.14
	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	6.39	10.42	12.50	(1.81)	0.07	0.47
	Stormwater Design - Quality & Quantity Control	6.17	10.75	10.50	(2.07)	0.04	0.54
	Green Building Index Facilitator	6.11	10.83	10.00	(2.07)	0.04	0.53
(1) Contractor & (2) Others	Environmental Tobacco Smoke (ETS) Control	5.89	9.50	8.00	(1.59)	0.11	0.44
	Integrated Pest Management, Erosion Control & Landscape Management	6.33	8.50	12.00	(1.06)	0.29	0.29
	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	6.00	9.25	9.00	(1.44)	0.15	0.40
	Stormwater Design - Quality & Quantity Control	5.50	10.38	4.50	(2.18)	0.03	0.60
	Green Building Index Facilitator	5.33	10.75	3.00	(2.41)	0.02	0.67

Profession		Mean Rank (1)	Mean Rank (2)	Mann-Whitney U (U)	*Z*	Asymp. Sig. (2-tailed) (ρ)	Effect Size (*r*)
(1) Sub Contractor & (2) Quantity Surveyor	Environmental Tobacco Smoke (ETS) Control	5.50	12.80	4.50	(1.13)	0.26	0.23
	Integrated Pest Management, Erosion Control & Landscape Management	5.50	12.80	4.50	(1.08)	0.28	0.22
	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	5.00	12.83	4.00	(1.13)	0.26	0.23
	Stormwater Design - Quality & Quantity Control	15.00	12.39	9.00	(0.39)	0.69	0.08
	Green Building Index Facilitator	11.00	12.57	10.00	(0.22)	0.82	0.05
(1) Sub Contractor & (2) M&E Engineer	Environmental Tobacco Smoke (ETS) Control	2.50	8.39	1.50	(1.64)	0.10	0.42
	Integrated Pest Management, Erosion Control & Landscape Management	1.00	8.50	-	(1.85)	0.06	0.48
	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	2.00	8.43	1.00	(1.48)	0.14	0.38
	Stormwater Design - Quality & Quantity Control	3.50	8.32	2.50	(1.11)	0.27	0.29
	Green Building Index Facilitator	1.50	8.46	0.50	(1.67)	0.10	0.43
(1) Sub Contractor & (2) Civil Engineer	Environmental Tobacco Smoke (ETS) Control	1.50	4.42	0.50	(1.32)	0.19	0.50
	Integrated Pest Management, Erosion Control & Landscape Management	1.50	4.42	0.50	(1.58)	0.11	0.60
	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	1.50	4.42	0.50	(1.39)	0.16	0.53
	Stormwater Design - Quality & Quantity Control	2.50	4.25	1.50	(0.87)	0.39	0.33
	Green Building Index Facilitator	2.50	4.25	1.50	(0.79)	0.43	0.30

Profession		Mean Rank (1)	Mean Rank (2)	Mann-Whitney U (U)	*Z*	Asymp. Sig. (2-tailed) (ρ)	Effect Size (*r*)
(1) Sub Contractor & (2) Others	Environmental Tobacco Smoke (ETS) Control	1.00	3.50	-	(1.49)	0.14	0.67
	Integrated Pest Management, Erosion Control & Landscape Management	1.00	3.50	-	(2.00)	0.05	0.89
	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	1.00	3.50	-	(1.49)	0.14	0.67
	Stormwater Design - Quality & Quantity Control	1.50	3.38	0.50	(1.22)	0.22	0.55
	Green Building Index Facilitator	1.50	3.38	0.50	(1.22)	0.22	0.55
(1) Quantity Surveyor & (2) M&E Engineer	Environmental Tobacco Smoke (ETS) Control	14.65	26.14	61.00	(3.31)	0.00	0.54
	Integrated Pest Management, Erosion Control & Landscape Management	15.13	25.36	72.00	(2.94)	0.00	0.48
	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	15.20	25.25	73.50	(2.82)	0.00	0.46
	Stormwater Design - Quality & Quantity Control	14.39	26.57	55.00	(3.49)	0.00	0.57
	Green Building Index Facilitator	14.78	25.93	64.00	(3.16)	0.00	0.52
(1) Quantity Surveyor & (2) Civil Engineer	Environmental Tobacco Smoke (ETS) Control	14.00	18.83	46.00	(1.38)	0.17	0.26
	Integrated Pest Management, Erosion Control & Landscape Management	13.57	20.50	36.00	(1.87)	0.06	0.35
	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	13.74	19.83	40.00	(1.62)	0.10	0.30
	Stormwater Design - Quality & Quantity Control	13.43	21.00	33.00	(2.08)	0.04	0.39
	Green Building Index Facilitator	13.98	18.92	45.50	(1.31)	0.19	0.24

Profession		Mean Rank (1)	Mean Rank (2)	Mann-Whitney U (U)	*Z*	Asymp. Sig. (2-tailed) (ρ)	Effect Size (*r*)
(1) Quantity Surveyor & (2) Others	Environmental Tobacco Smoke (ETS) Control	12.83	20.75	19.00	(2.05)	0.04	0.39
	Integrated Pest Management, Erosion Control & Landscape Management	12.61	22.00	14.00	(2.30)	0.02	0.44
	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	13.13	19.00	26.00	(1.42)	0.16	0.27
	Stormwater Design - Quality & Quantity Control	12.65	21.75	15.00	(2.26)	0.02	0.43
	Green Building Index Facilitator	12.83	20.75	19.00	(1.90)	0.06	0.37
(1) M&E Engineer & (2) Civil Engineer	Environmental Tobacco Smoke (ETS) Control	11.64	7.83	26.00	(1.56)	0.12	0.35
	Integrated Pest Management, Erosion Control & Landscape Management	10.46	10.58	41.50	(0.05)	0.96	0.01
	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	11.25	8.75	31.50	(0.93)	0.35	0.21
	Stormwater Design - Quality & Quantity Control	11.36	8.50	30.00	(1.06)	0.29	0.24
	Green Building Index Facilitator	11.07	9.17	34.00	(0.73)	0.46	0.16
(1) M&E Engineer & (2) Others	Environmental Tobacco Smoke (ETS) Control	9.93	8.00	22.00	(0.81)	0.42	0.19
	Integrated Pest Management, Erosion Control & Landscape Management	9.07	11.00	22.00	(0.81)	0.42	0.19
	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	9.71	8.75	25.00	(0.34)	0.73	0.08
	Stormwater Design - Quality & Quantity Control	9.71	8.75	25.00	(0.34)	0.73	0.08
	Green Building Index Facilitator	9.32	10.13	25.50	(0.31)	0.76	0.07

Profession		Mean Rank (1)	Mean Rank (2)	Mann-Whitney U (U)	*Z*	Asymp. Sig. (2-tailed) (ρ)	Effect Size (*r*)
(1) Civil Engineer & (2) Others	Environmental Tobacco Smoke (ETS) Control	5.00	6.25	9.00	(0.71)	0.48	0.22
	Integrated Pest Management, Erosion Control & Landscape Management	5.17	6.00	10.00	(0.82)	0.41	0.26
	Green Vehicle Priority - Low Emitting & Fuel Efficient Vehicle	5.33	5.75	11.00	(0.22)	0.82	0.07
	Stormwater Design - Quality & Quantity Control	5.00	6.25	9.00	(0.75)	0.45	0.24
	Green Building Index Facilitator	5.00	6.25	9.00	(0.72)	0.47	0.23

APPENDIX E: Questionnaire

Liew Phik Yin

AT 65, Ametis Terraces, No.1, Jalan BP 14,
Bandar Bukit Puchong 2,
47120, Puchong, Selangor.

13rd December 2011

Dear Sir/Madam,

RE: Questionnaire Survey on Barriers in the Implementation of GBI's Criteria to Attain the GBI Certification

Good day to you.

I am Liew Phik Yin, a Quantity Surveying final year undergraduate from Universiti Tunku Abdul Rahman. Currently, I am conducting a study on the topic of Green Building Index (GBI) Malaysia.

The purpose of this research is to investigate the inherent barriers in implementation of GBI's criterias to attain GBI certificates. By identifying the root cause of the barriers, recommended solutions will be generated to ease the process of attaining the GBI certifications.

I would like to invite you to participate in this research by completing a set of questionnaire as attached. It would be greatly appreciated if you could kindly take some time to provide answers to each question and revert.

Should you have any pertinent questions about the survey, please do not hesitate to contact me at *016-2829901* or email to *phik.yin@gmail.com* . All information shared will be kept confidential.

Thank you in advance for your kind assistance.

Your sincerely,
Liew Phik Yin.

Barriers in the Implementation of GBI's Criteria to Attain GBI Certification.

Questionnaire

The following table has shown the criteria to achieve for attaining the Green Building Index (GBI) certification.
Please rate the level of achievability in scoring the criteria by highlighting the numbers provided.
Please state the reason for criteria that you marked as "Most Difficult / 1". The reason stated will enable this research to find out the cause of barriers in attaining the GBI certification.

	Criteria	Easiest	Easy	Neutral	Difficult	Most Difficult
1	Minimum Energy Efficient (EE) Performance *Reason:*	**5**	**4**	**3**	**2**	**1**
2	Lighting Zoning *Reason:*	**5**	**4**	**3**	**2**	**1**
3	Electrical Sub-metering *Reason:*	**5**	**4**	**3**	**2**	**1**
4	Advanced EE Performance based on Overall Thermal Transfer Value(OTTV) *Reason:*	**5**	**4**	**3**	**2**	**1**
5	Advanced EE Performance based on Roof Thermal Transfer Value (RTTV) *Reason:*	**5**	**4**	**3**	**2**	**1**
6	Home Office & Connectivity *Reason:*	**5**	**4**	**3**	**2**	**1**
7	Renewable Energy *Reason:*	**5**	**4**	**3**	**2**	**1**
8	Advanced or Improved EE Performance – Building Energy Intensity (BEI) *Reason:*	**5**	**4**	**3**	**2**	**1**
9	Enhanced Commissioning *Reason:*	**5**	**4**	**3**	**2**	**1**
10	On-going Post Occupancy Commissioning *Reason:*	**5**	**4**	**3**	**2**	**1**
11	Energy Efficiency Verification *Reason:*	**5**	**4**	**3**	**2**	**1**
12	Sustainable Maintenance *Reason:*	**5**	**4**	**3**	**2**	**1**
13	Minimum Indoor Air Quality Performance *Reason:*	**5**	**4**	**3**	**2**	**1**
14	Environmental Tobacco Smoke (ETS) Control *Reason:*	**5**	**4**	**3**	**2**	**1**
15	Sound Insulation *Reason:*	**5**	**4**	**3**	**2**	**1**
16	Good Quality Construction *Reason:*	**5**	**4**	**3**	**2**	**1**

	Criteria	Easiest	Easy	Neutral	Difficult	Most Difficult
17	Carbon Dioxide Monitoring and Control *Reason:*	**5**	**4**	**3**	**2**	**1**
18	Indoor Air Pollutant & Industrial Chemical Exposure *Reason:*	**5**	**4**	**3**	**2**	**1**
19	Mould Prevention *Reason:*	5	4	3	2	1
20	Thermal Comfort: Design & Controllability of Systems *Reason:*	5	4	3	2	1
21	Air Change Effectiveness *Reason:*	5	4	3	2	1
22	Breakout Spaces *Reason:*	5	4	3	2	1
23	Daylighting *Reason:*	5	4	3	2	1
24	Daylight Glare Control *Reason:*	5	4	3	2	1
25	Electric Lighting Levels *Reason:*	5	4	3	2	1
26	High Frequency Ballasts *Reason:*	5	4	3	2	1
27	External Views *Reason:*	5	4	3	2	1
28	Internal Noise Levels *Reason:*	5	4	3	2	1
29	IAQ Before & During Occupancy *Reason:*	5	4	3	2	1
30	Post Occupancy Comfort Survey: Verification *Reason:*	5	4	3	2	1
31	GBI Rated Design & Construction *Reason:*	5	4	3	2	1
32	Building Exterior Management *Reason:*	5	4	3	2	1
33	Integrated Pest Management, Erosion Control & Landscape Management *Reason:*	5	4	3	2	1
34	Green Vehicle Priority – Low Emitting & Fuel Efficient Vehicle *Reason:*	5	4	3	2	1
35	Parking Capacity *Reason:*	5	4	3	2	1
36	Greenery & Roof *Reason:*	5	4	3	2	1
37	Building User Manual *Reason:*	5	4	3	2	1
38	Open Spaces, Landscaping & Heat Island Effect *Reason:*	5	4	3	2	1
39	Re-development of Existing Sites & Brownfield Sites *Reason:*	5	4	3	2	1
40	Avoiding Environmentally Sensitive Areas *Reason:*	5	4	3	2	1

	Criteria	Easiest	Easy	Neutral	Difficult	Most Difficult
41	Development Density & Community Connectivity *Reason:*	5	4	3	2	1
42	Environment Management *Reason:*	5	4	3	2	1
43	Noise Pollution *Reason:*	5	4	3	2	1
44	Quality Assessment System in Construction (QLASSIC) *Reason:*	5	4	3	2	1
45	Workers' Site Amenities *Reason:*	5	4	3	2	1
46	Public Transportation Access & Transportation Plan *Reason:*	5	4	3	2	1
47	Cargo Delivery Route and Proximity *Reason:*	5	4	3	2	1
48	Stormwater Design – Quality & Quantity Control *Reason:*	5	4	3	2	1
49	Materials Reuse and Selection *Reason:*	5	4	3	2	1
50	Recycled Content Materials *Reason:*	5	4	3	2	1
51	Sustainable Timber *Reason:*	5	4	3	2	1
52	Regional Materials *Reason:*	5	4	3	2	1
53	Sustainable Purchasing Policy *Reason:*	5	4	3	2	1
54	Storage, Collection & Disposal of Recyclables *Reason:*	5	4	3	2	1
55	Refrigerants & Clean Agents *Reason:*	5	4	3	2	1
56	Construction Waste Management *Reason:*	5	4	3	2	1
57	Rainwater Harvesting *Reason:*	5	4	3	2	1
58	Water Recycling *Reason:*	5	4	3	2	1
59	Water Efficient Irrigation/Landscaping *Reason:*	5	4	3	2	1
60	Water Efficient Fittings *Reason:*	5	4	3	2	1
61	Metering & Leak Detection System *Reason:*	5	4	3	2	1
62	Innovation & Environmental Design Initiatives *Reason:*	5	4	3	2	1
63	Green Building Index Facilitator *Reason:*	5	4	3	2	1

Personal Details

1. Profession :

[ ] Client [ ] Developer

[ ] Architect [ ] Contractor

[ ] Sub-contractor [ ] Quantity Surveyor

[ ] M&E Engineer [ ] Civil Engineer

Others:______________________________

2. Primary types of projects involved : [ ] Residential [ ] Commercial [ ] Industrial

3. Have you ever involved in a green building's project? : [ ] Yes [ ] No

4. Are you a GBI facilitator?: [ ] Yes [ ] No

5. How long have you been working in construction industry? : ____________years

6. Name : ________________________________

7. Company Name : ________________________

8. Email Address : _________________________

9. Contact Number : ________________________

Much appreciated for your time in completing this questionnaire.
All information shared will be used for this study and will be kept CONFIDENTIAL.
Thank you.